Radio Test Report

For

CP-8821 IP Phone with

2.4 GHz/5.0 GHz Wi-Fi Radio 802.11a/ac/b/g/n + Bluetooth v3.0

FCC ID: LDK88211296

UNII-2C (5470-5725 MHz)

Against the following Specifications:

CFR47 Part 15.407

ACCREDITED

Cisco Systems
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Title: See EDCS
Revision: See EDCS

This report replaces any previously entered test report under EDCS – **875271**. This test report has been electronically authorized and archived using the CISCO Engineering Document Control system. Test Report Template EDCS# 1526148

SECTION 1: OVERVIEW 5

1.1 Test Summary 5

SECTION 2: ASSESSMENT INFORMATION 6

2.1 General 6

2.2 Units of Measurement 6

2.3 Date of testing (initial sample receipt date to last date of testing) 7

2.4 Report Issue Date 8

2.5 Testing facilities 8

2.6 Equipment Assessed (EUT) 9

2.7 EUT Description 9

SECTION 3: RESULT SUMMARY 10

3.1 Results Summary Table 10

SECTION 4: SAMPLE DETAILS 12

4.1 Sample Details 12

4.2 Antenna Information 12

4.3 Mode of Operation Details 12

APPENDIX A: CONDUCTED TEST RESULTS 13

A.1 DUTY CYCLE 14

A.1.1 Duty Cycle Test Method 14

A.1.2 Duty Cycle Data Table 15

A.1.3 Duty Cycle Graphical Test results 16

A.2 FREQUENCY STABILITY 17

A.2.1 Limits. 17

A.2.2 Frequency Stability Test Data 17

A.3 99% AND 26DB BANDWIDTH 19

A.3.1 Limits. 19

A.3.2 Test Procedure 19

A.3.3 99% and 26dB Bandwidth Data Table 20

A.3.4 99% Occupied & 26dB Bandwidth Graphical Test Results 21

A.4 MAXIMUM CONDUCTED OUTPUT POWER 24

A.4.1 Limits. 24

A.4.2 Test Procedure 24

A.4.3 Maximum Conducted Output Power Data Table 25

A.4.4 Maximum Conducted Output Power Graphical Test Results 27

A.5 POWER SPECTRAL DENSITY 30

A.5.1 Limits. 30

A.5.2 Test Procedure 30

A.5.3 Power Spectral Density Data Table 31

A.5.4 Power Spectral Density Graphical Test Results 32

A.6 CONDUCTED BAND EDGE & UNDESIRABLE EMISSIONS IN NON-RESTRICTED BANDS 35

A.6.1 Limits 35

A.6.2 Test Procedure 35

A.6.3 Conducted Band Edge & Non-restricted band Recorded Test Data 36

A.6.4 Conducted Band Edge and Non-restricted Band Graphical Test Results 37

A.7 RESTRICTED BANDS 40

A.7.1 Limits. 40

A.7.2 Test Procedure 41

A.7.3 Restricted Bands Recorded Test Data 42

A.7.4 Restricted Bands Graphical Test Results 43

APPENDIX B: RADIATED TEST RESULTS 45

B.1 RADIATED SPURIOUS EMISSIONS & RESTRICTED BANDS 45

B.1.1 Limits. 47

B.1.2 Test Procedure 49

B.1.3 Transmitter Radiated Spurious Emissions Graphical Data Results 51

B.2 AC CONDUCTED EMISSIONS 58

B.2.1 Limits. 58

B.2.2 Test Procedure 59

B.2.3 Recorded Test Data and Graphical Test results 61

APPENDIX C: LIST OF TEST EQUIPMENT USED TO PERFORM THE TEST 62

APPENDIX D: ABBREVIATION KEY AND DEFINITIONS 63

APPENDIX E: SOFTWARE USED TO PERFORM TESTING 64

APPENDIX F: TEST PROCEDURES 65

APPENDIX G: SCOPE OF ACCREDITATION 66

APPENDIX H: TEST ASSESSMENT PLAN 67

APPENDIX I: WORST CASE JUSTIFICATION 67

Section 1: Overview

1.1 Test Summary

The samples were assessed against the tests detailed in section 3 under the requirements of the following specifications:

Specifications
CFR47 15.407

Measurements were made in accordance with

- ANSI C63.10:2013 Procedure for Compliance Testing of Unlicensed Wireless Devices
- KDB Publication No. 789033 - D02 General UNII Test Procedures New Rules v01
- KDB 644545 D03 Guidance for IEEE 802.11ac v01

Section 2: Assessment Information

2.1 General

This report contains an assessment of an apparatus against Radio Standards based upon tests carried out on the samples submitted. The testing was performed by and for the use of Cisco systems Inc.:

With regard to this assessment, the following points should be noted:

a) The results contained in this report relate only to the items tested and were obtained in the period between the date of the initial assessment and the date of issue of the report. Manufactured products will not necessarily give identical results due to production and measurement tolerances.

b) The apparatus was set up and exercised using the configuration and modes of operation defined in this report only.

c) Where relevant, the apparatus was only assessed using the susceptibility criteria defined in this report and the Test Assessment Plan (TAP).

d) All testing was performed under the following environmental conditions:

Temperature	15°C to 35°C (54°F to 95°F)
Atmospheric Pressure	860mbar to 1060mbar (25.4" to 31.3")
Humidity	10% to 75*%

e) All AC testing was performed at one or more of the following supply voltages:
110V 60 Hz (+/-20%)

2.2 Units of Measurement

The units of measurements defined in the appendices are reported in specific terms, which are test dependent. Where radiated measurements are concerned these are defined at a particular distance. Basic voltage measurements are defined in units of [dBuV]

As an example, the basic calculation for all measurements is as follows:

Emission level [dBuV] = Indicated voltage level [dBuV] + Cable Loss [dB] + Other correction factors [dB]

The combinations of correction factors are dependent upon the exact test configurations [see test equipment lists for further details] and may include:-

Antenna Factors, Pre Amplifier Gain, LISN Loss, Pulse Limiter Loss and Filter Insertion Loss..

Note: to convert the results from dBuV/m to uV/m use the following formula:-

Level in uV/m = Common Antilogarithm [(X dBuV/m)/20] = Y uV/m

Measurement Uncertainty Values

voltage and power measurements	± 2 dB
conducted EIRP measurements	± 1.4 dB
radiated measurements	± 3.2 dB
frequency measurements	± 2.4 10-7
temperature measurements	± 0.54º.
humidity measurements	± 2.3%
DC and low frequency measurements	± 2.5%.

Where relevant measurement uncertainty levels have been estimated for tests performed on the apparatus. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Radiated emissions (expanded uncertainty, confidence interval 95%)

30 MHz - 300 MHz	+/- 3.8 dB
300 MHz - 1000 MHz	+/- 4.3 dB
1 GHz - 10 GHz	+/- 4.0 dB
10 GHz - 18GHz	+/- 8.2 dB
18GHz - 26.5GHz	+/- 4.1 dB
26.5GHz - 40GHz	+/- 3.9 dB

Conducted emissions (expanded uncertainty, confidence interval 95%)

30 MHz – 40GHz	+/- 0.38 dB

A product is considered to comply with a requirement if the nominal measured value is below the limit line. The product is considered to not be in compliance in case the nominal measured value is above the limit line.

2.3 Date of testing (initial sample receipt date to last date of testing)

September 08 2015 to June 01, 2016

2.4 Report Issue Date

Cisco uses an electronic system to issue, store and control the revision of test reports. This system is called the Engineering Document Control System (EDCS). The actual report issue date is embedded into the original file on EDCS. Any copies of this report, either electronic or paper, that are not on EDCS must be considered uncontrolled

2.5 Testing facilities

This assessment was performed by:

Testing Laboratory
Cisco Systems, Inc.
125 West Tasman Drive (Building P)
San Jose, CA 95134
USA

Headquarters
Cisco Systems, Inc.,
170 West Tasman Drive
San Jose, CA 95134,
USA

Registration Numbers for Industry Canada

Cisco System Site	Address	Site Identifier
Building P, 10m Chamber	125 West Tasman Dr San Jose, CA 95134	Company #: 2461N-2
Building P, 5m Chamber	125 West Tasman Dr San Jose, CA 95134	Company #: 2461N-1
Building I, 5m Chamber	285 W. Tasman Drive San Jose, California 95134	Company #: 2461M-1
Building N, 5m Chamber	125 Rio Robles, San Jose, California 95134	Company #: 6111A

Test Engineer
Danh Le

2.6 Equipment Assessed (EUT)

CP-8821

2.7 EUT Description

The CP-8821 is the next generation IP Phone with Wi-Fi (802.11a/ac/b/g/n) and Bluetooth module support. The specification is applied to IEEE802.11a/ac/b/g/n + Bluetooth Basic rate/ EDR

Here is a brief summary of the Heracles hardware:

- IEEE 802.11 a/b/g/n/ac compliant wireless LAN
- USB 2.0/OTG interface (Shared with docking connector)
- 2.4-inch TFT LCD display, with 240 x 320 pixels, 16M colors
- Capacitive standard 12-key backlit keypad, 2 soft keys, volume and ringer control hard keys, mute hard Key, speakerphone hard key, push-to-talk hard key, dedicated end call button (shared with power-on and off function) and send/dial button, 5-way joystick/navigation keys
- 512MB LPDDR2 RAM, 4GB eMMC flash storage, version4.41
- 2020 mAh removable standard battery
- Ring, Wireless low signal, battery condition and MWI LED
- Shared antenna for 802.11a/b/g/n/ac and Bluetooth Basic rate /EDR.
- Separate ringer and voice speaker
- 3.5 mm headset interface
- Vibrate alert support
- Two Digital Microphone & Two loud speaker Interface
- Audio codec support, MP3, WAV, AAC etc.
- IP67 certified water and dust proof.

Section 3: Result Summary

3.1 Results Summary Table

Conducted emissions

Basic Standard	Technical Requirements / Details	Result
15.407	**99% & 26 dB Bandwidth**: The 99% occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. There is no limit for 99% OBW. The 26 dB emission is the width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 26 dB relative to the maximum level measured in the fundamental emission.	**Pass**
15.407 (a)(2)	**Maximum Conducted Output Power**: For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.	**Pass**
15.407 (a)(2)	**Power Spectral Density** The maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.	**Pass**
15.407 (b)(3)	**Band Edge / Out-of-Band Emissions**: For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.	**Pass**
15.407 (b)(7) 15.205 15.209	**Restricted band**: Unwanted emissions must comply with the general field strength limits set forth in §15.209.	**Pass**
15.207	**AC conducted Emissions:** U-NII devices using an AC power line are required to comply also with the conducted limits set forth in §15.207.	**Pass**

Radiated Emissions (General requirements)

Basic Standard	Technical Requirements / Details	Result
15.205 15.209 15.407 (b)(3)	**TX Spurious Emissions:** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the filed strength limits table in these sections. For transmitters operating in the 5.47 - 5.725 GHz band: all emissions outside of the 5.47 - 5.725 GHz band shall not exceed an EIRP of -27dBm/MHz.	**Pass**

Section 4: Sample Details

Note: Each sample was evaluated to ensure that its condition was suitable to be used as a test sample prior to the commencement of testing. Please also refer to the "Justification for Worst Case Test Configuration" section of this report for further details on the selection of EUT samples.

4.1 Sample Details

Sample No.	Equipment Details	Manufacturer	Hardware Rev.	Firmware Rev.	Software Rev.	Serial Number
S01 (Radiated)	CP-8821	Cisco Systems, Inc.	01	Sip8821.10-3-2HER-157 dev	Rootfs8821.10-3-2HER-157-dev	FCH192180BK
S02 (Conducted)	CP-8821	Cisco Systems, Inc.	01	Sip8821.10-2-1-HE1-3.1-diagnostics	Sip8821.10-2-1-HE1-3.1-diagnostics	FCH18528TEU

4.2 Antenna Information

The following antennas are supported by this product series.

Frequency (MHz)	Part Number	Antenna Type	Antenna Gain (dBi)
5470-5725	Internal	Monopole	3

4.3 Mode of Operation Details

Mode#	Description	Comments
1	Diagnostic	Diagnostic version allows to do conducted testing at antenna port of EUT. Image version : **Sip8821.10-2-1-HE1-3.1-diagnostics**

Measurements were made in accordance with

- ANSI C63.10:2013 Procedure for Compliance Testing of Unlicensed Wireless Devices
- KDB 789033 D02 General UNII Test Procedures New Rules v01
- KDB 644545 D03 Guidance for IEEE 802.11ac v01

Appendix A: Conducted Test Results

Target Maximum Channel Power
The following table details the maximum supported Total Channel Power for all operating modes.

Operating Mode	Maximum Channel Power (dBm)		
	Frequency (MHz)		
	5500	5660	5700
802.11a	13	17	11
802.11n HT20	10	17	8
802.11ac VHT20	7	17	7

Operating Mode	Maximum Channel Power (dBm)	
	Frequency (MHz)	
	5510	5670
802.11n HT40	11	11
802.11ac VHT40	11	11

Operating Mode	Maximum Channel Power (dBm)
	Frequency (MHz)
	5530
802.11ac VHT80	10

A.1 Duty Cycle

Duty Cycle Test Requirement
From KDB 789033 D02 General UNII Test Procedures New Rules v01
B. Duty Cycle (x), Transmission Duration (T), and Maximum Power Control Level

1. All measurements are to be performed with the EUT transmitting at 100 percent duty cycle at its maximum power control level; however, if 100 percent duty cycle cannot be achieved, measurements of duty cycle, x, and maximum-power transmission duration, *T*, are required for each tested mode of operation.

A.1.1 Duty Cycle Test Method

From KDB 789033 D02 General UNII Test Procedures New Rules v01:
B. Duty Cycle (x), Transmission Duration (T), and Maximum Power Control Level

The zero-span mode on a spectrum analyzer or EMI receiver, if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW ≥ EBW if possible; otherwise, set RBW to the largest available value. Set VBW ≥ RBW. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T, where T is defined in section II.B.1.a), and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

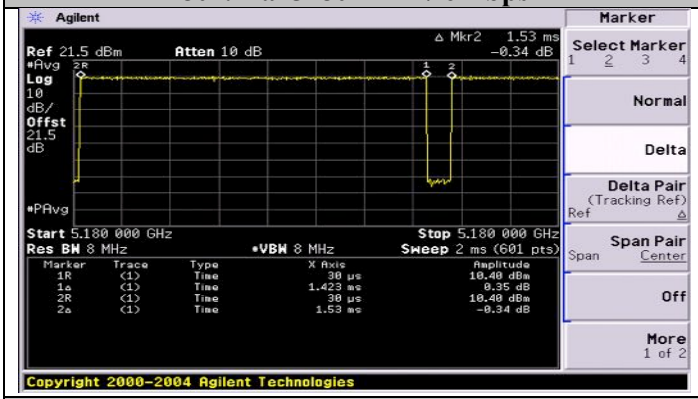
A.1.2 Duty Cycle Data Table

Mode	Data Rate (Mbps)	On-time (ms)	Total on+off Time (ms)	Duty Cycle (%)	Correction Factor (dB)
802.11a	6	1.423	1.53	93.007	0.315
802.11n20	MCS0	1.333	1.433	93.022	0.315
802.11n40	MCS0	0.3533	0.4567	77.360	1.113
802.11ac20	MCS0	1.34	1.443	92.863	0.332
802.11ac40	MCS0	0.670	0.770	87.013	0.605
802.11ac80	MCS0	0.330	0.4333	76.160	1.183

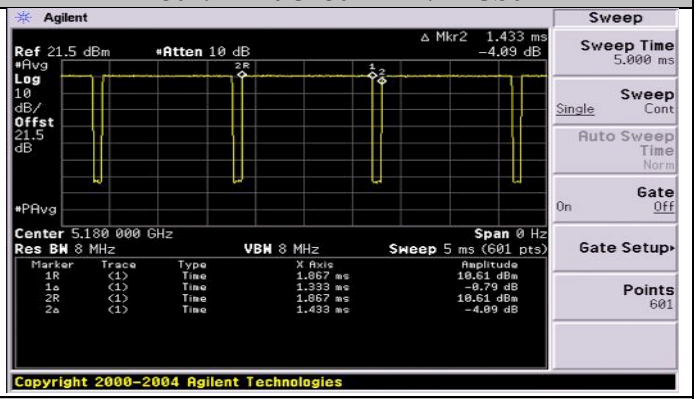
A.1.3 Duty Cycle Graphical Test results

Duty Cycle

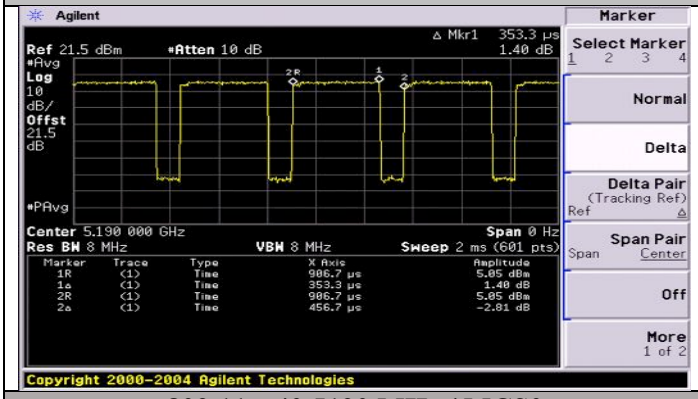
802.11a 5180 MHz / 6Mbps



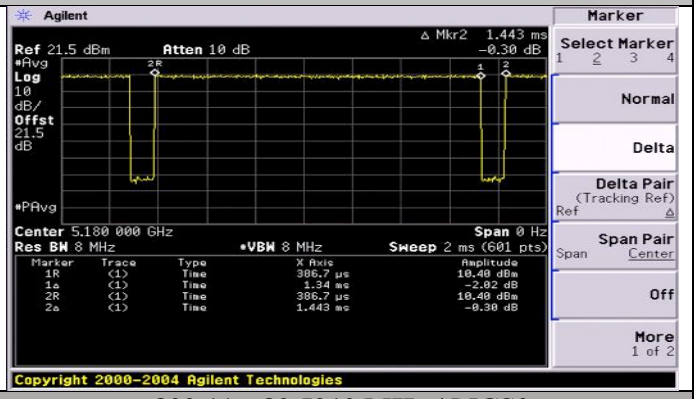
802.11n20 5180 MHz / MCS0



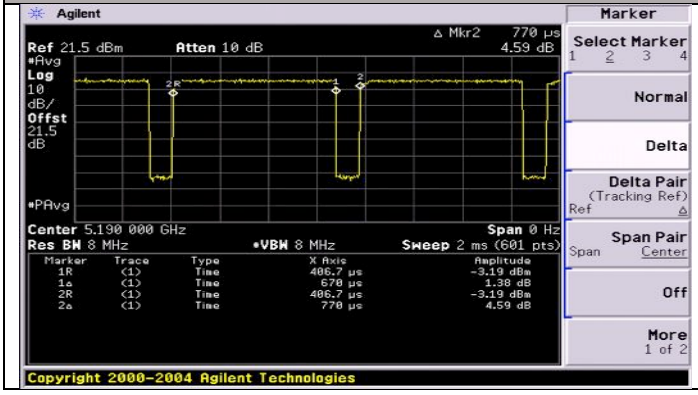
802.11n40 5190 MHz / MCS0



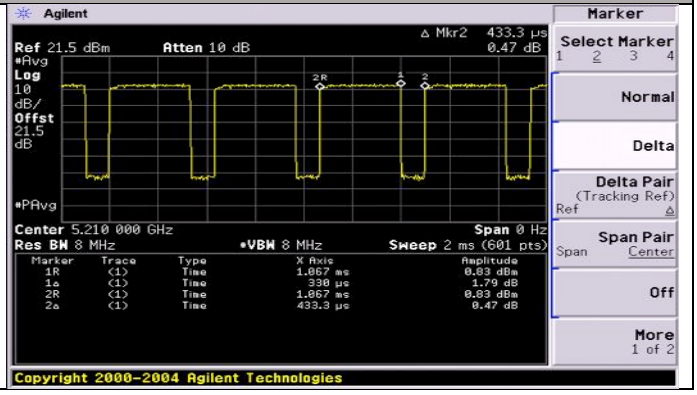
802.11ac20 5180 MHz / MCS0



802.11ac40 5190 MHz / MCS0



802.11ac80 5210 MHz / MCS0



A.2 Frequency Stability

A.2.1 Limits.

FCC 15.407(g): Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

A.2.2 Frequency Stability Test Data

Temperature	Voltage	Frequency (MHz)	S.A Reading (MHz)	Deviation (ppm)	Limit (ppm)	Result
802.11a 5500MHz						
0 degree	**Low**	**5500**	5500.0251	4.563636364	≤ 20	Pass
	Nominal		5500.0511	9.290909091	≤ 20	Pass
	High		5500.0511	9.290909091	≤ 20	Pass
Normal Temperature	**Low**	**5500**	5499.9975	-0.45454545	≤ 20	Pass
	Nominal		5499.9648	-6.4	≤ 20	Pass
	High		5499.9983	-0.30909090	≤ 20	Pass
50 degree	**Low**	**5500**	5499.9816	-3.34545454	≤ 20	Pass
	Nominal		5499.9816	-3.34545454	≤ 20	Pass
	High		5499.9816	-3.34545454	≤ 20	Pass
802.11a 5660MHz						
0 degree	**Low**	**5660**	5660.0252	4.45229682	≤ 20	Pass
	Nominal		5660.0529	9.346289753	≤ 20	Pass
	High		5660.0529	9.346289753	≤ 20	Pass
Normal Temperature	**Low**	**5660**	5659.9975	-0.44964028	≤ 20	Pass
	Nominal		5659.9640	-6.360424028	≤ 20	Pass
	High		5659.9975	-0.441696113	≤ 20	Pass
50 degree	**Low**	**5660**	5659.9807	-3.40989399	≤ 20	Pass
	Nominal		5659.9807	-3.409893993	≤ 20	Pass
	High		5659.9807	-3.409893993	≤ 20	Pass
802.11a 5700MHz						
0 degree	**Low**	**5700**	5700.0252	4.421052632	≤ 20	Pass
	Nominal		5700.0537	9.421052632	≤ 20	Pass
	High		5700.0529	9.280701754	≤ 20	Pass
Normal Temperature	**Low**	**5700**	5699.9975	-0.441696113	≤ 20	Pass
	Nominal		5699.9640	-6.315789474	≤ 20	Pass
	High		5699.9975	-0.438596491	≤ 20	Pass
50 degree	**Low**	**5700**	5699.9807	-3.385964912	≤ 20	Pass
	Nominal		5699.9816	-3.228070175	≤ 20	Pass
	High		5699.9807	-3.385964912	≤ 20	Pass

Frequency Stability Test Data (continue)

Temperature	Voltage	Frequency (MHz)	S.A Reading (MHz)	Deviation (ppm)	Limit (ppm)	Result
802.11n40 5510MHz						
0 degree	**Low**	**5510**	5510.0243	4.410163339	≤ 20	Pass
	Nominal		5510.0519	9.41923775	≤ 20	Pass
	High		5510.0519	9.41923775	≤ 20	Pass
Normal Temperature	**Low**	**5510**	5509.9975	-0.45372050	≤ 20	Pass
	Nominal		5509.9647	-6.40653357	≤ 20	Pass
	High		5509.9975	-0.45372050	≤ 20	Pass
50 degree	**Low**	**5510**	5509.9815	-3.35753176	≤ 20	Pass
	Nominal		5509.9815	-3.35753176	≤ 20	Pass
	High		5509.9815	-3.35753176	≤ 20	Pass
802.11n40 5670MHz						
0 degree	**Low**	**5670**	5670.0243	4.285714286	≤ 20	Pass
	Nominal		5670.0544	9.594356261	≤ 20	Pass
	High		5670.0536	9.453262787	≤ 20	Pass
Normal Temperature	**Low**	**5670**	5669.9975	-0.44091710	≤ 20	Pass
	Nominal		5669.9639	-6.36684303	≤ 20	Pass
	High		5669.9975	-0.44091710	≤ 20	Pass
50 degree	**Low**	**5670**	5669.9807	-3.40388007	≤ 20	Pass
	Nominal		5669.9807	-3.40388007	≤ 20	Pass
	High		5669.9815	-3.26278659	≤ 20	Pass
802.11ac80 5530MHz						
0 degree	**Low**	**5530**	5530.0243	4.394213382	≤ 20	Pass
	Nominal		5530.0368	6.65461121	≤ 20	Pass
	High		5530.0528	9.547920434	≤ 20	Pass
Normal Temperature	**Low**	**5530**	5529.9975	-0.45207956	≤ 20	Pass
	Nominal		5529.9647	-6.38336347	≤ 20	Pass
	High		5529.9975	-0.45207956	≤ 20	Pass
50 degree	**Low**	**5530**	5529.9815	-3.34538878	≤ 20	Pass
	Nominal		5529.9815	-3.34538878	≤ 20	Pass
	High		5529.9815	-3.34538878	≤ 20	Pass

A.3 99% and 26dB Bandwidth

The 99% occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. There is no limit for 99% OBW.

The 26 dB emission is the width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 26 dB relative to the maximum level measured in the fundamental emission.

A.3.1 Limits.

There is no requirement for the value of bandwidth. Power measurements are made using the 99% Bandwidth as the integration bandwidth.

A.3.2 Test Procedure

Ref. KDB 789033 D02 General UNII Test Procedure New Rules v01 section C (1)

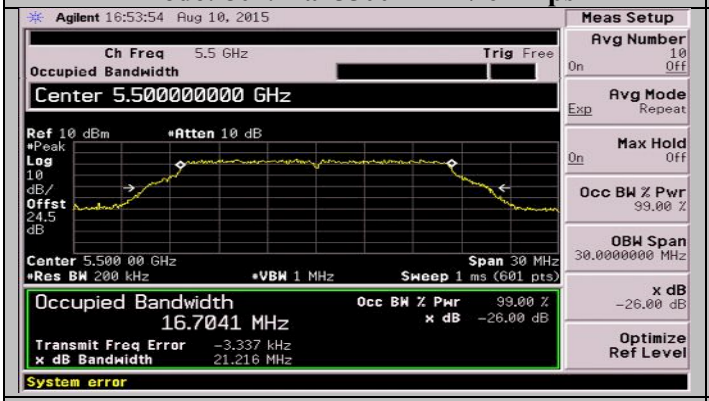
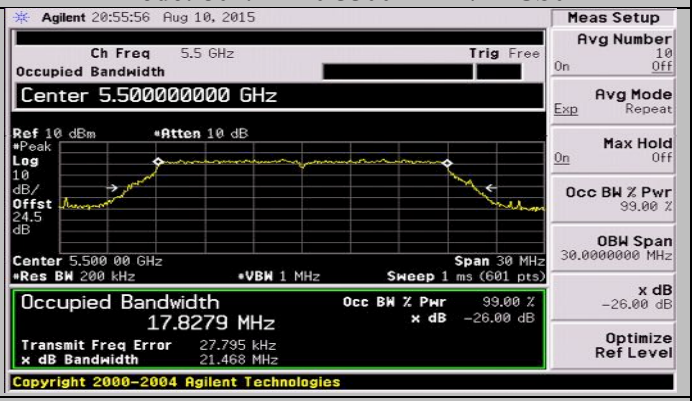
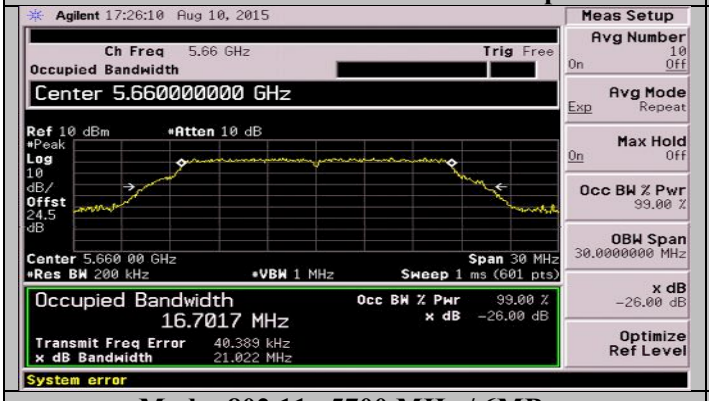
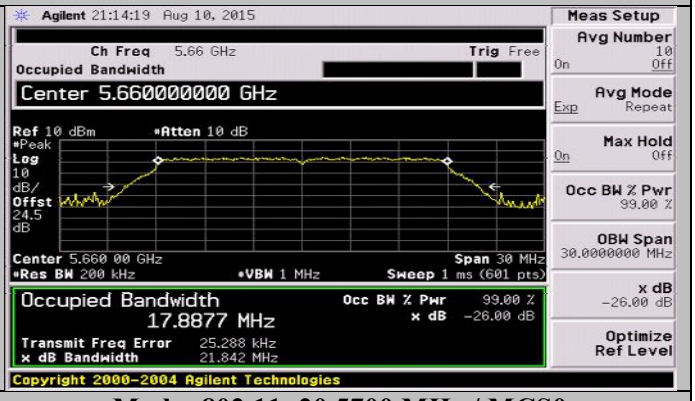
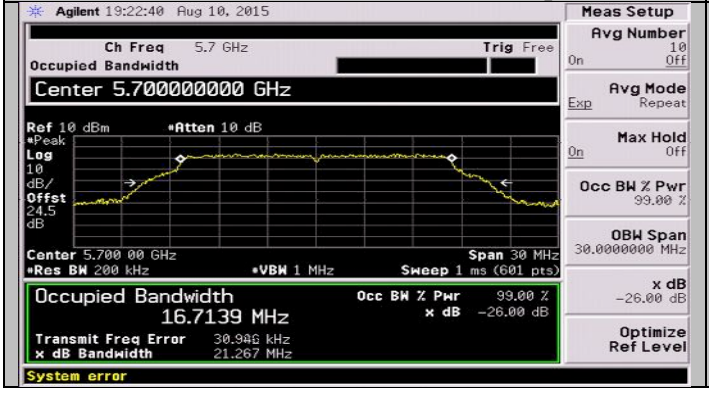
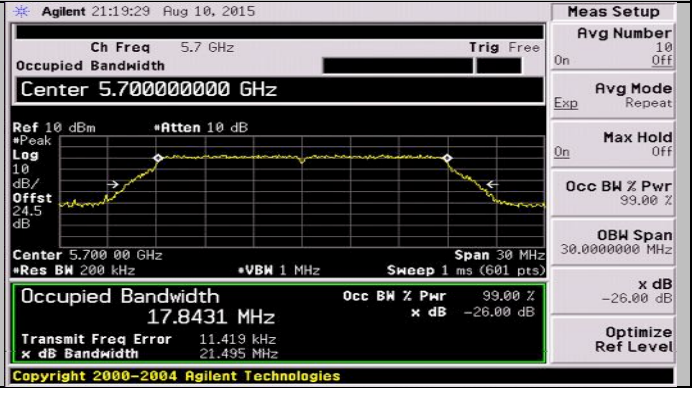
99% BW and EBW (-26dB) Test Procedure
1. Set the radio in the continuous transmitting mode. 2. Allow the trace to stabilize. 3. Setting the x-dB bandwidth mode to -26B and OBW power function to 99% within the measurement set up function. 4. Select the automatic OBW measurement function of an instrument to perform bandwidth measurement. 5. Capture graphs and record pertinent measurement data.

99% BW and EBW (-26dB) Test parameters
Span = 1.5 x to 5.0 times OBW RBW = approx. 1% to 5% of the OBW VBW ≥ 3 x RBW Detector = Peak or where practical sample shall be used Trace = Max. Hold

A.3.3 99% and 26dB Bandwidth Data Table

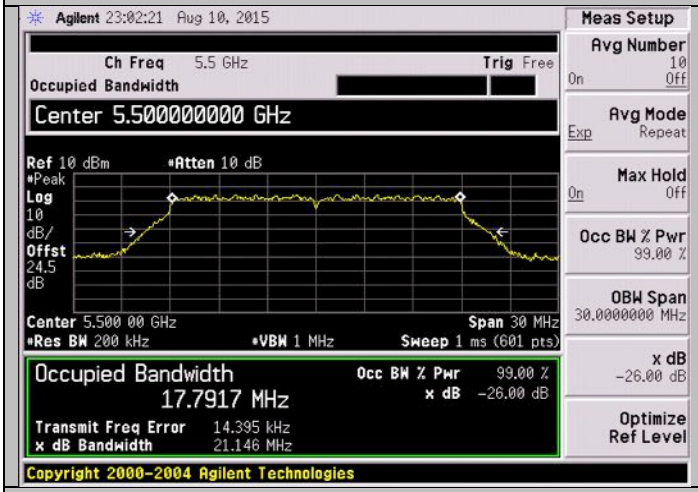
Channel No	Frequency (MHz)	Mode	Data Rate (Mbps)	99% BW (MHz)	26dB BW (MHz)
100	5500	802.11a	6	16.7041	21.409
132	5660	802.11a	6	16.7017	21.022
140	5700	802.11a	6	16.7139	21.267
100	5500	802.11n20	MCS0	17.8279	21.468
132	5660	802.11n20	MCS0	17.8877	21.608
140	5700	802.11n20	MCS0	17.8431	21.495
102	5510	802.11n40	MCS0	36.2810	39.944
134	5670	802.11n40	MCS0	36.2364	39.808
100	5500	802.11ac	MCS0	17.7917	21.146
132	5660	802.11ac	MCS0	17.7586	21.440
140	5700	802.11ac	MCS0	17.7734	21.188
102	5510	802.11ac40	MCS0	36.2157	39.709
134	5670	802.11ac40	MCS0	36.2619	39.664
106	5530	802.11ac80	MCS0	75.6288	81.319

A.3.4 99% Occupied & 26dB Bandwidth Graphical Test Results

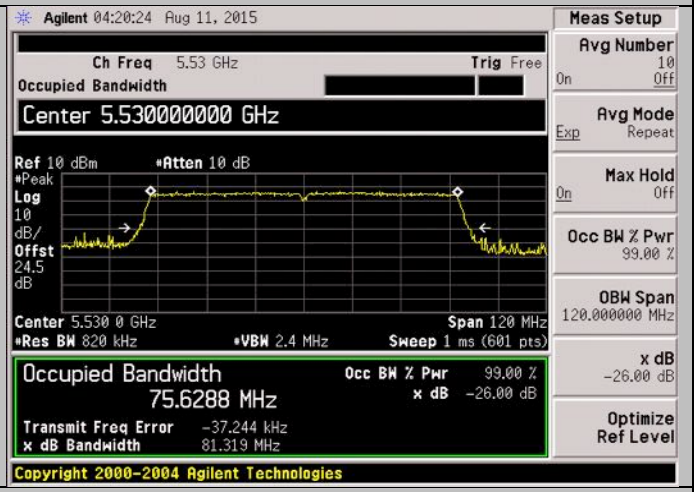
99% & 26 dB Bandwidth	
Mode: 802.11a 5500 MHz / 6MBps	**Mode: 802.11n20 5500 MHz / MCS0**
	
Mode: 802.11a 5660 MHz / 6MBps	**Mode: 802.11n20 5660 MHz / MCS0**
	
Mode: 802.11a 5700 MHz / 6MBps	**Mode: 802.11n20 5700 MHz / MCS0**
	

99% & 26 dB Bandwidth

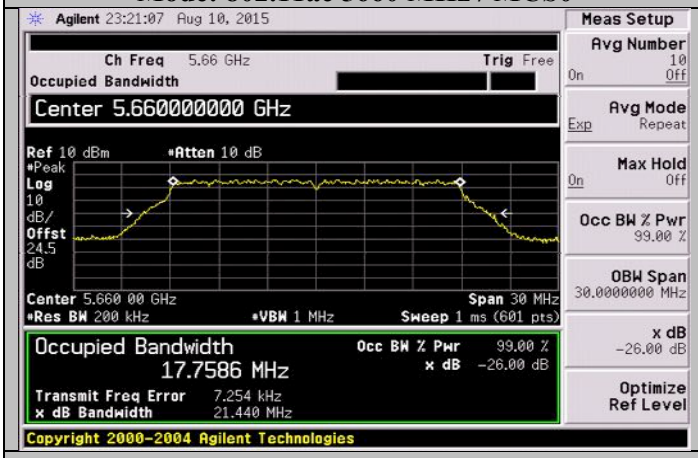
Mode: 802.11ac 5500 MHz / MCS0



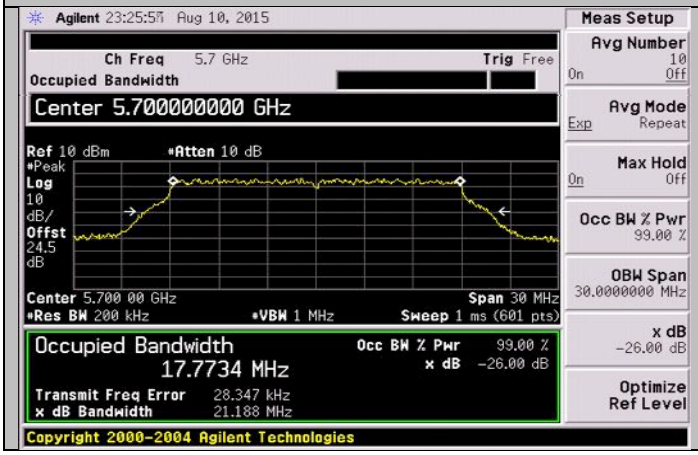
Mode: 802.11ac80 5530 MHz / MCS0

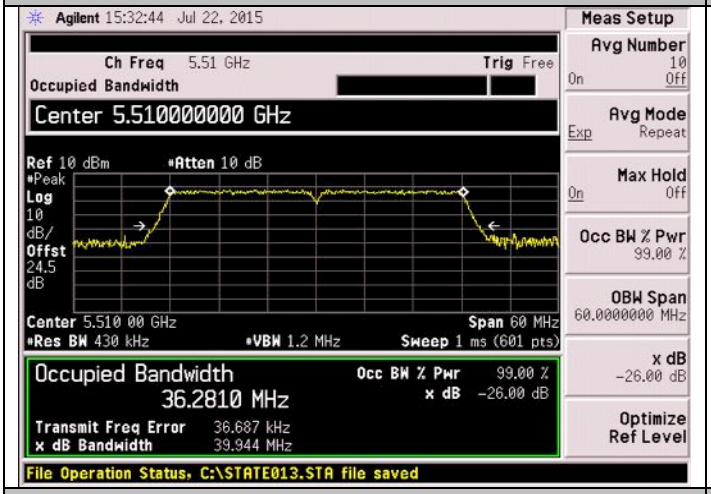
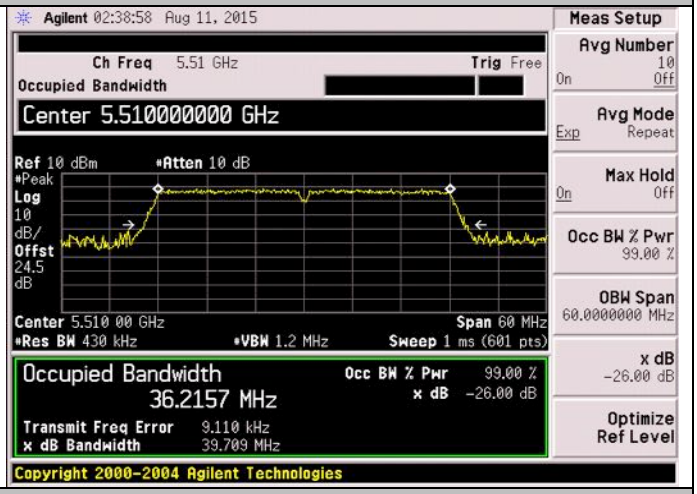
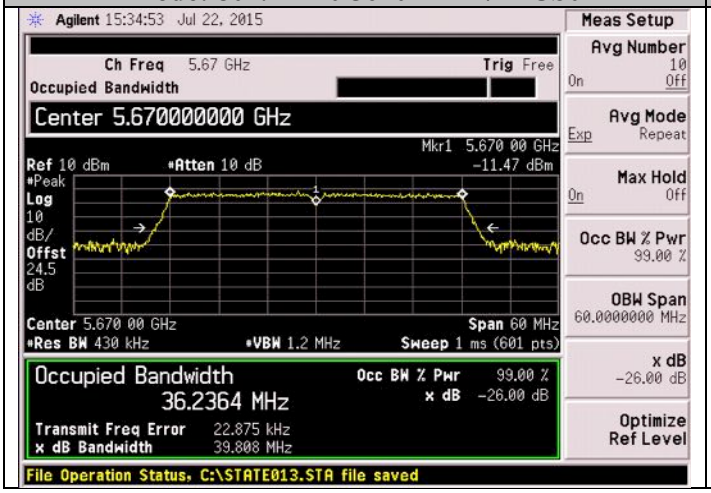
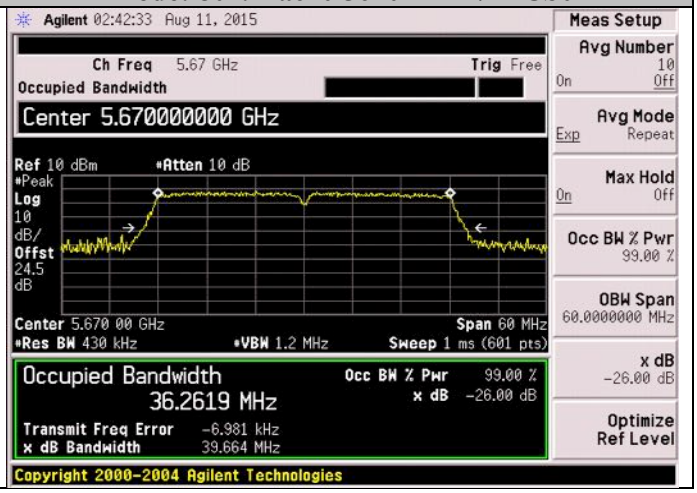


Mode: 802.11ac 5660 MHz / MCS0



802.11ac 5700 MHz MCS0



99% & 26 dB Bandwidth	
Mode: 802.11n40 5510 MHz / MCS0	**Mode: 802.11ac40 5510 MHz / MCS0**
	
Mode: 802.11n40 5670 MHz / MCS0	**Mode: 802.11ac40 5670 MHz / MCS0**
	

A.4 Maximum Conducted Output Power

Maximum Conducted Output Power is defined as the total transmit power delivered to all antenna when the transmitter is operating at its maximum control level.

A.4.1 Limits.

FCC 15.407(a) (2)

For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

A.4.2 Test Procedure

Ref. KDB 789033 D02 General UNII Test Procedures New Rules v01

Test Procedure
1. Set the radio in the transmitting mode 2. Compute power by integrating the spectrum across the EBW (or alternatively entire 99% OBW) of the signal using the instrument's band power measurement function. The integration shall be performed using the spectrum analyzer band-power measurement function with band limits set equal to the EBW or the OBW band edges. 3. Capture graphs and record pertinent measurement data. 4. Make the following adjustments to the peak value of the spectrum, by adding duty cycle correction factor to the measured value

Measurement using a Spectrum Analyzer or EMI Receiver (SA), (d) Method SA-2

Test parameters
(i) Set span to encompass the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal. (ii) Set RBW = 1 MHz (iii) Set VBW ≥ 3 MHz (iv) Number of points in sweep ≥ 2 Span / RBW. (This ensures that bin-to-bin spacing is ≤ RBW/2, so that narrowband signals are not lost between frequency bins.) (v) Sweep time = auto. (vi) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode. (vii) Do not use sweep triggering. Allow the sweep to "free run". (viii) Trace average at least 100 traces in power averaging (i.e., RMS) mode; however, the number of traces to be averaged shall be increased above 100 as needed to ensure that the average accurately represents the true average over the on and off periods of the transmitter.

Limits Calculation

26dB EBW (MHz)	10*log10B (dB)	11+10*log10B (dBm)	*250mW ~ (dBm)	Conducted Power Limits (dBm)
802.11a				
21.409	13.30596382	24.30596382	23.97940009	**24**
21.022	13.22674032	24.22674032	23.97940009	**24**
21.267	13.27706231	24.27706231	23.97940009	**24**
802.11n20				
21.468	13.31791587	24.31791587	23.97940009	**24**
21.608	13.34614571	24.34614571	23.97940009	**24**
21.495	13.32337449	24.32337449	23.97940009	**24**
802.11n40				
39.944	16.01451553	27.01451553	23.97940009	**24**
39.808	15.99970359	26.99970359	23.97940009	**24**
802.11ac20				
21.146	13.25228228	24.25228228	23.97940009	**24**
21.440	13.31224781	24.31224781	23.97940009	**24**
21.188	13.26089964	24.26089964	23.97940009	**24**
802.11ac40				
39.709	15.9888895	26.9888895	23.97940009	**24**
39.664	15.98396509	26.98396509	23.97940009	**24**
802.11ac80				
81.319	19.10192029	30.10192029	23.97940009	**24**

***Note: 250mW is converted to 24dBm approximately.**
Note2: ~ represents for approximation.

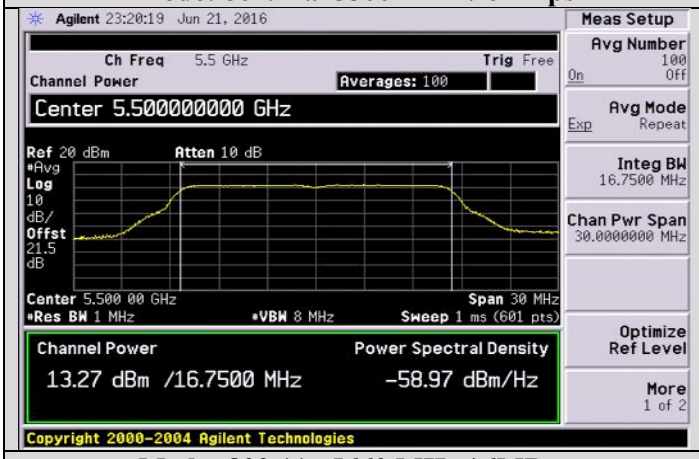
A.4.3 Maximum Conducted Output Power Data Table

Channel No	Frequency (MHz)	Antenna Gain (dBi)	DCCF (dB)	Max Output Power (dBm)	Corrected Max Output Power (dBm)	Limits (dBm)	Results
Mode/Data rate (Mbps): 802.11a/(6Mbps)							
100	5500	3	0.315	13.27	13.58	24	**Pass**
132	5660	3	0.315	17.39	17.70	24	**Pass**
140	5700	3	0.315	10.88	11.19	24	**Pass**
Mode/Data rate (Mbps): 802.11n20/(MCS0)							
100	5500	3	0.315	10.24	10.56	24	**Pass**
132	5660	3	0.315	16.85	17.16	24	**Pass**
140	5700	3	0.315	7.40	7.72	24	**Pass**
Mode/Data rate (Mbps): 802.11n40/(MCS0)							
102	5510	3	1.113	10.01	11.12	24	**Pass**
134	5670	3	1.113	10.13	11.24	24	**Pass**
Mode/Data rate (Mbps): 802.11ac20/(MCS0)							
100	5500	3	0.332	7.35	7.682	24	**Pass**
132	5660	3	0.332	16.94	17.27	24	**Pass**
40	5700	3	0.332	6.44	6.772	24	**Pass**
Mode/Data rate (Mbps): 802.11ac40/(MCS0)							
102	5510	3	0.605	10.12	10.72	24	**Pass**
134	5670	3	0.605	10.06	10.66	24	**Pass**
Mode/Data rate (Mbps): 802.11ac80/(MCS0)							
106	5530	3	1.183	9.37	10.55	24	**Pass**

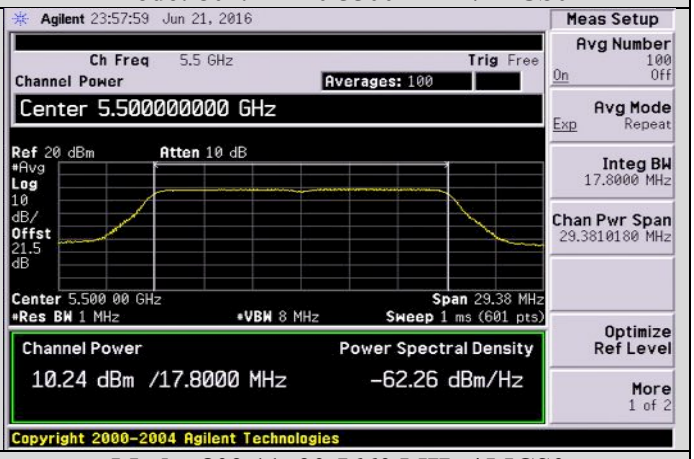
A.4.4 Maximum Conducted Output Power Graphical Test Results

Maximum Conducted Output Power

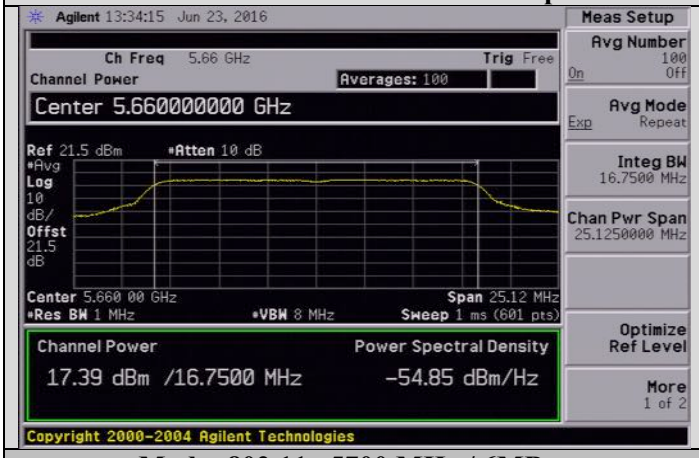
Mode: 802.11a 5500 MHz / 6MBps



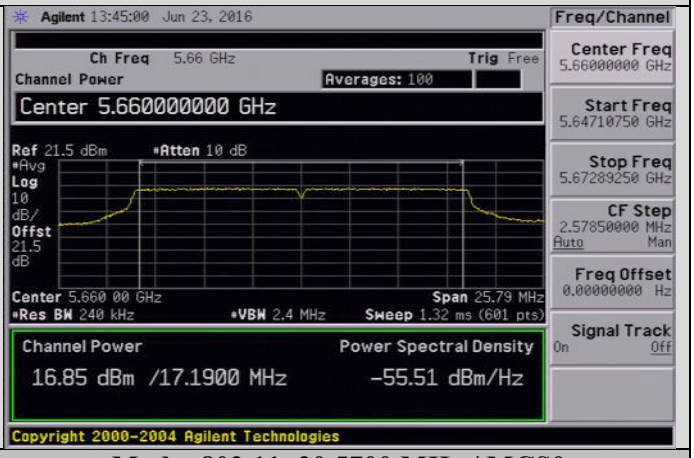
Mode: 802.11 n20 5500 MHz / MCS0



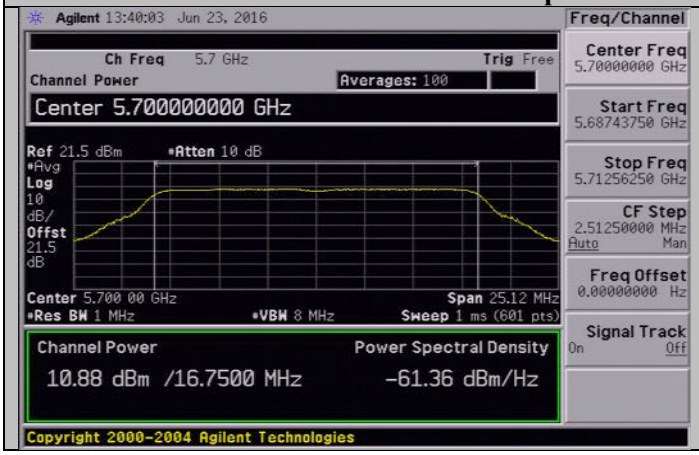
Mode: 802.11a 5660 MHz / 6MBps



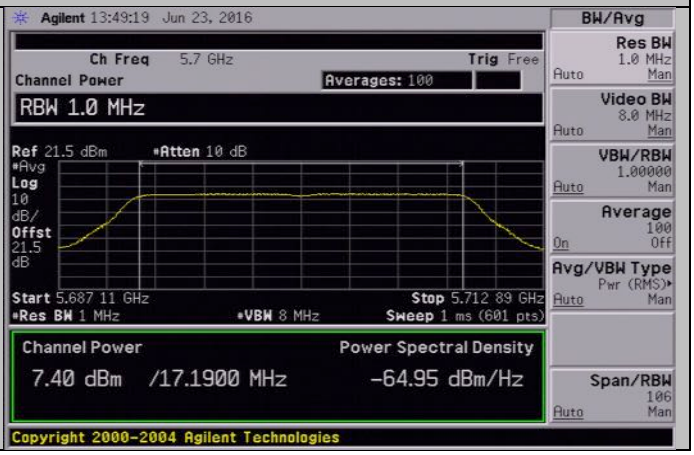
Mode: 802.11n20 5660 MHz / MCS0



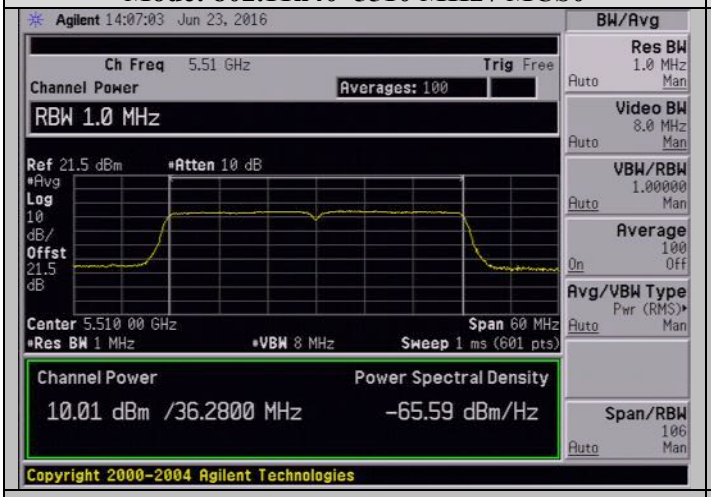
Mode: 802.11a 5700 MHz / 6MBps



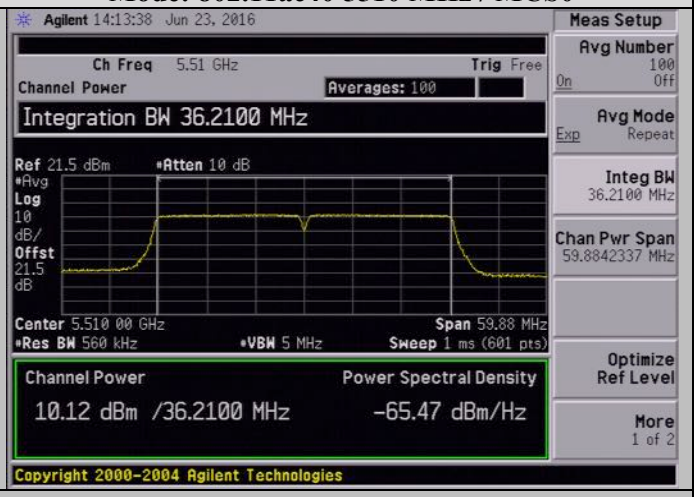
Mode: 802.11n20 5700 MHz / MCS0



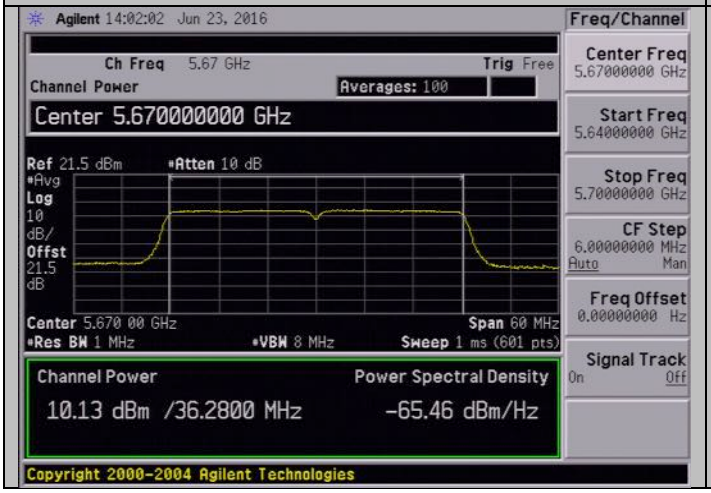
Mode: 802.11n40 5510 MHz / MCS0



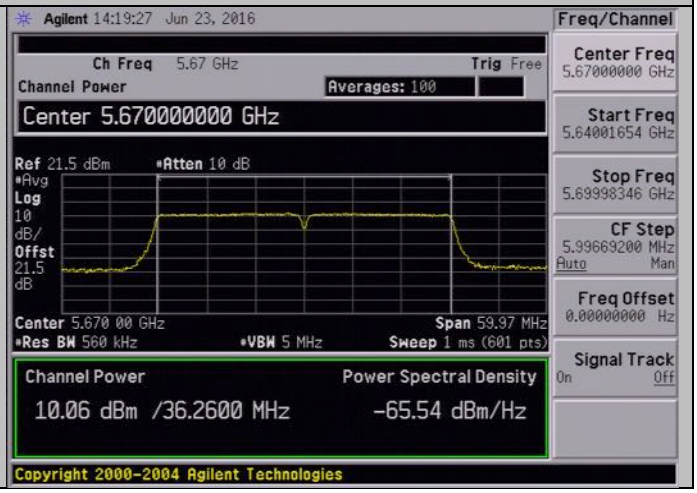
Mode: 802.11ac40 5510 MHz / MCS0



Mode: 802.11n40 5670 MHz / MCS0

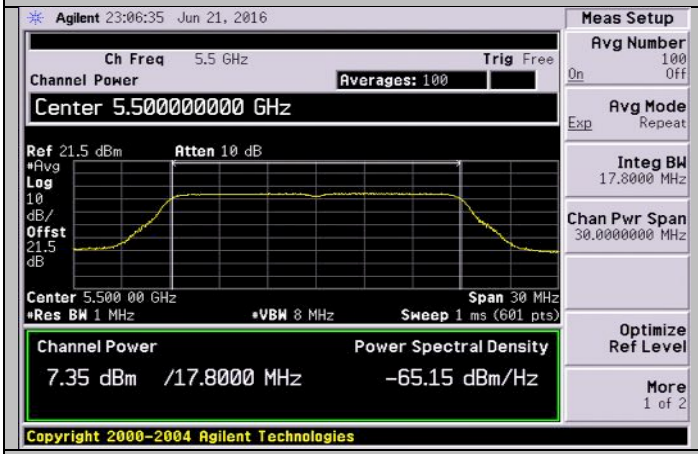


Mode: 802.11ac40 5670 MHz / MCS0

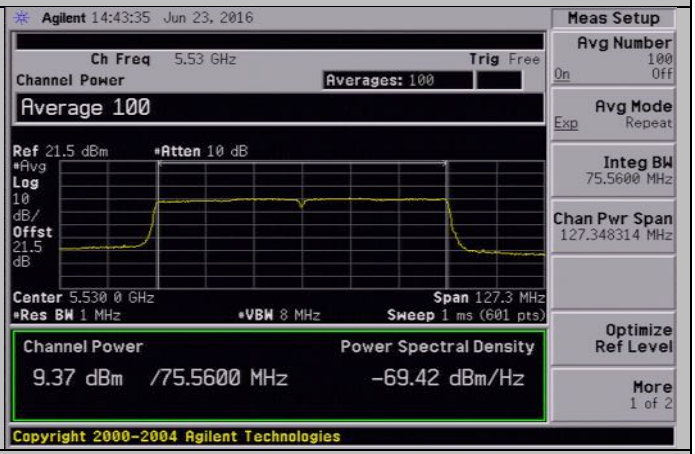


Maximum Conducted Output Power

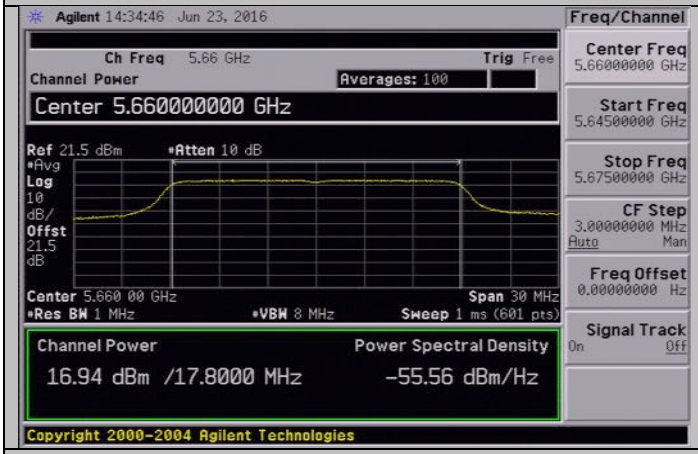
Mode: 802.11ac 5500 MHz / MCS0



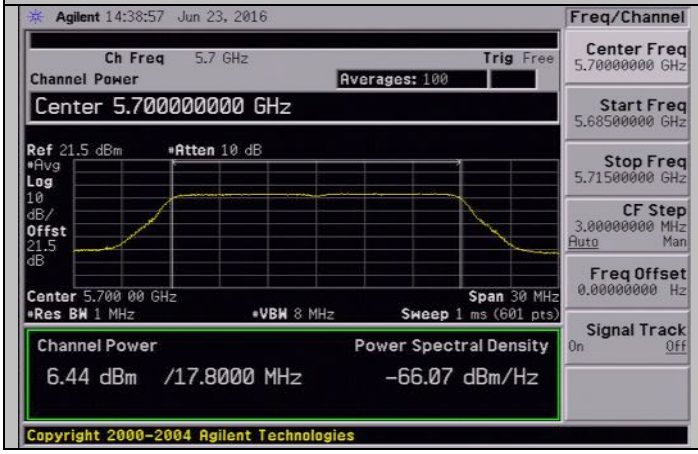
Mode: 802.11ac80 5530 MHz / MCS0



Mode: 802.11ac 5660 MHz / MCS0



Mode: 802.11ac 5700 MHz / MCS0



A.5 Power Spectral Density

The Power Spectral Density is the total energy output per unit bandwidth from a pulse or sequence of pulses for which the transmit power is at its maximum level, divided by the total duration of the pulses, This total time does not include the time between pulses during which the transmit power is off or below its maximum level.

A.5.1 Limits.

FCC 15.407 (2)
For the 5.25-5.35 GHz and 5.47-5.725 GHz bands … the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

A.5.2 Test Procedure

Ref. KDB 789033 D02 General UNII Test Procedures New Rules v01

Test Procedure
1. Set the radio in the transmitting mode
2. Use the peak search function on the instrument to find the peak of the spectrum and record its value.
3. Make the following adjustments to the peak value of the spectrum, by adding duty cycle correction factor to the measured value.
4. Capture graphs and record pertinent measurement data.
5. The result is the Maximum PSD over 1 MHz reference bandwidth.

Measurement using a Spectrum Analyzer or EMI Receiver (SA), (d) Method SA-2

Test parameters
(i) Set span to encompass the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal. (ii) Set RBW = 1 MHz (iii) Set VBW ≥ 3 MHz (iv) Number of points in sweep ≥ 2 Span / RBW. (This ensures that bin-to-bin spacing is ≤ RBW/2, so that narrowband signals are not lost between frequency bins.) (v) Sweep time = auto. (vi) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode. (vii) Do not use sweep triggering. Allow the sweep to "free run". (viii) Trace average at least 100 traces in power averaging (i.e., RMS) mode; however, the number of traces to be averaged shall be increased above 100 as needed to ensure that the average accurately represents the true average over the on and off periods of the transmitter.

A.5.3 Power Spectral Density Data Table

Channel No	Frequency (MHz)	Antenna Gain (dBi)	DCCF (dB)	PSD (dBm/MHz)	Corrected PSD (dBm/MHz)	Limits (dBm/MHz)	Results
Mode/Data rate (Mbps): 802.11a/(6Mbps)							
100	5500	3	0.315	2.164	2.479	11	**Pass**
132	5660	3	0.315	5.809	6.124	11	**Pass**
140	5700	3	0.315	-0.396	-0.081	11	**Pass**
Mode/Data rate (Mbps): 802.11n20/(MCS0)							
100	5500	3	0.315	-1.435	-1.120	11	**Pass**
132	5660	3	0.315	5.566	5.881	11	**Pass**
140	5700	3	0.315	-3.938	-3.623	11	**Pass**
Mode/Data rate (Mbps): 802.11n40/(MCS0)							
102	5510	3	1.113	-5.080	-3.967	11	**Pass**
134	5670	3	1.113	-5.031	-3.918	11	**Pass**
Mode/Data rate (Mbps): 802.11ac20/(MCS0)							
100	5500	3	0.332	-4.610	-4.278	11	**Pass**
132	5660	3	0.332	5.289	5.621	11	**Pass**
140	5700	3	0.332	-4.963	-4.631	11	**Pass**
Mode/Data rate (Mbps): 802.11ac40/(MCS0)							
102	5510	3	1.113	-4.738	-3.625	11	**Pass**
134	5670	3	1.113	-4.981	-3.868	11	**Pass**
Mode/Data rate (Mbps): 802.11ac80/(MCS0)							
106	5530	3	1.183	-8.092	-6.909	11	**Pass**

A.5.4 Power Spectral Density Graphical Test Results

Power Spectral Density

Mode: 802.11a 5500 MHz / 6MBps

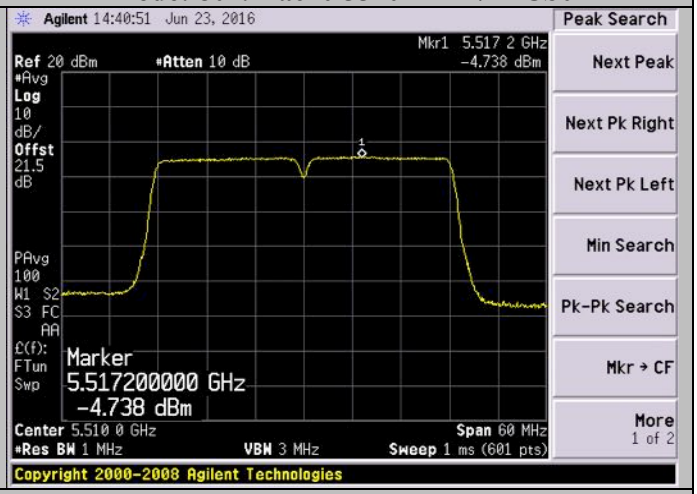
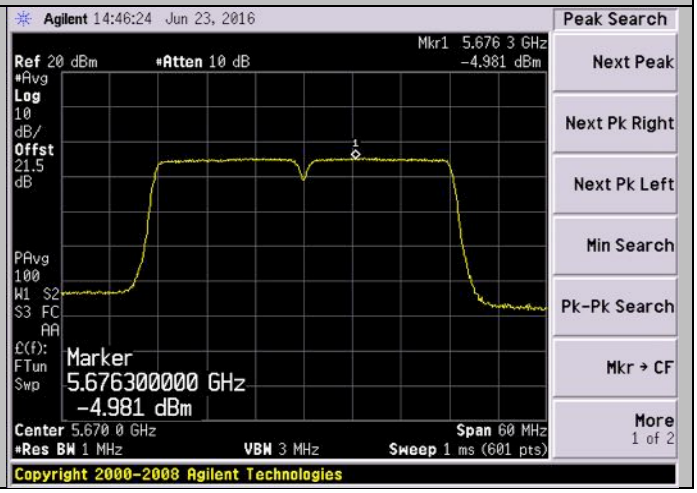
Mode: 802.11n20 5500 MHz / MCS0

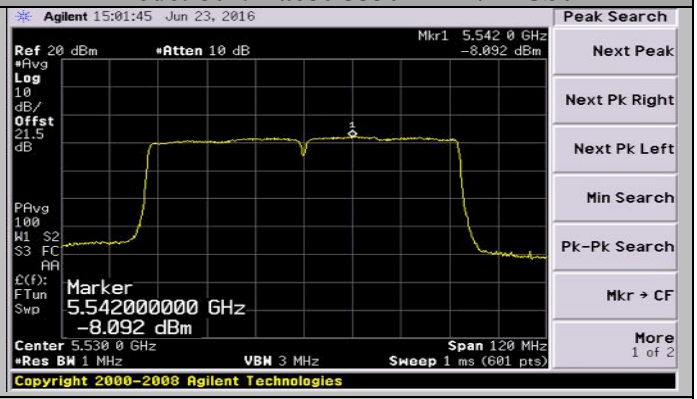
Mode: 802.11a 5660 MHz / 6MBps

Mode: 802.11n20 5660 MHz / MCS0

Mode: 802.11a 5700 MHz / 6 MBps

Mode: 802.11n20 5700 MHz / MCS0

Power Spectral Density	
Mode: 802.11n40 5510 MHz / MCS0	**Mode: 802.11ac40 5510 MHz / MCS0**
	
Mode: 802.11n40 5670 MHz / MCS0	**Mode: 802.11ac40 5670 MHz / MCS0**
	

Power Spectral Density	
Mode: 802.11ac 5500 MHz / MCS0	**Mode: 802.11ac80 5530 MHz / MCS0**
	
Mode: 802.11ac 56600 MHz / MCS0	
	
Mode: 802.11ac20 57000 MHz / MCS0	
	

A.6 Conducted Band Edge & Undesirable emissions in non-restricted bands

A.6.1 Limits

15.407(b) *Undesirable emission limits.* Except as shown in paragraph (b) (7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(3) For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz..

(8) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency band edges as the design of the equipment permits

A.6.2 Test Procedure

Ref. 789033 D02 General UNII Test Procedures New Rules v01
ANSI C63.10: 2013

Conducted Band Edge and Out-of-band Test Procedure
1. Connect the antenna port(s) to the spectrum analyzer input. 2. Place the radio in continuous transmit mode. Use the procedures in 789033 D02 General UNII Test Procedures New Rules v01 to substitute conducted measurements in place of radiated measurements. 3. Configure Spectrum analyzer as per test parameters below (be sure to enter all losses between the transmitter output and the spectrum analyzer). 4. Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands. 5. Place a marker at the end of the band edge closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands 6. Capture graphs and record pertinent measurement data.

ANSI C63.10: 2013 section 12.7.7.3 and section 12.7.6

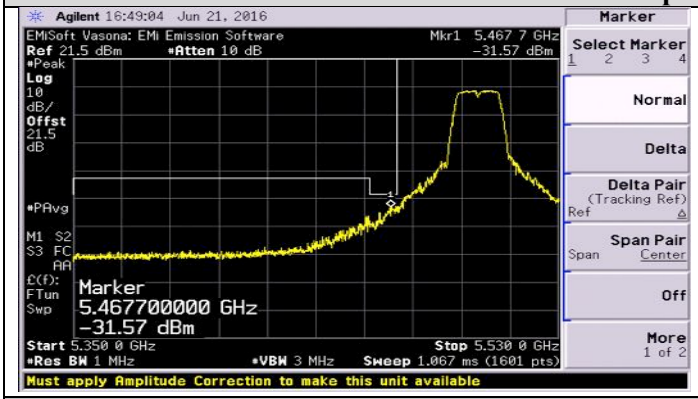
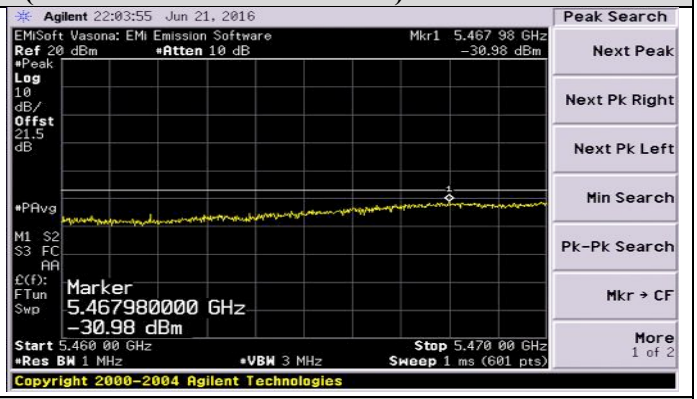
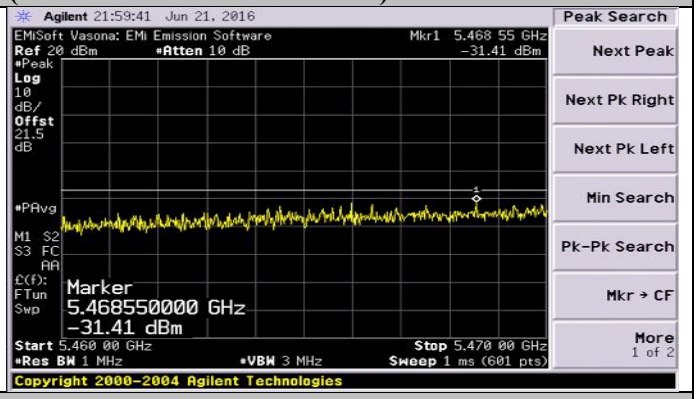
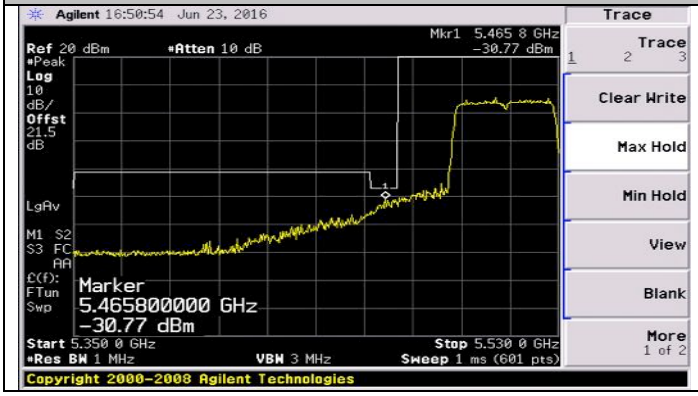
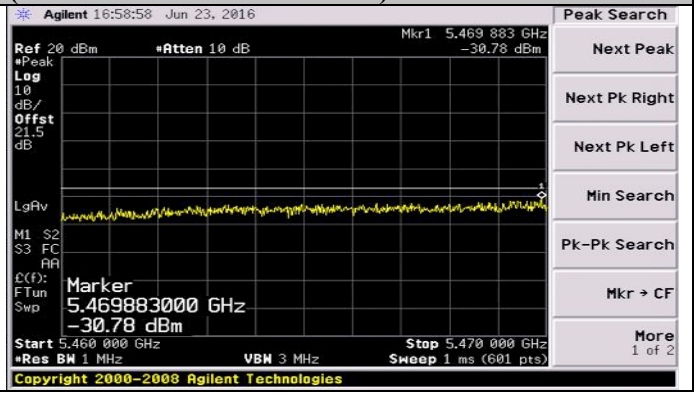
Conducted Band Edge and Out-of-band Test parameters
RBW = 1 MHz VBW ≥ 3MHz for Peak, 100Hz for Average Sweep = Auto couple Detector = Peak Trace = Max Hold.

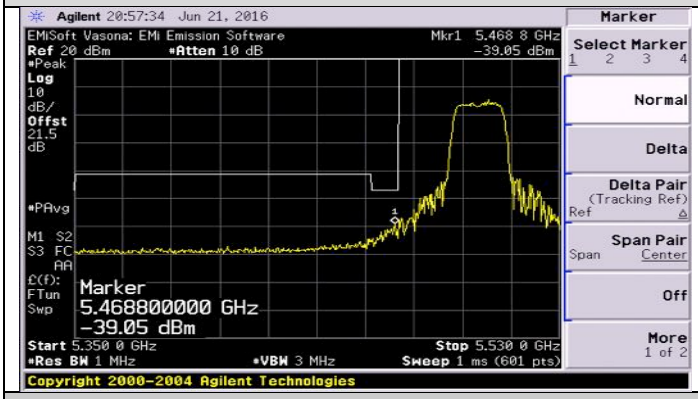
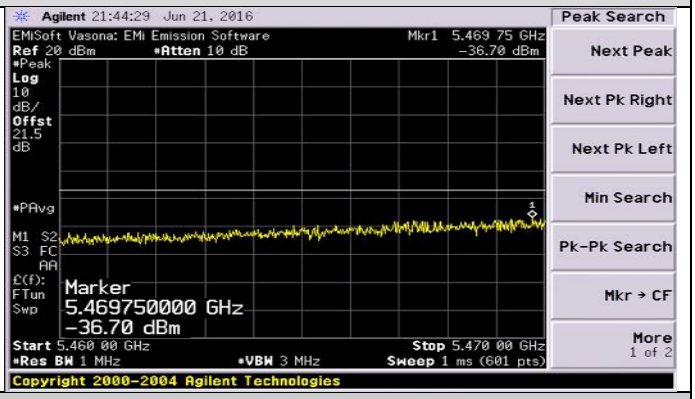
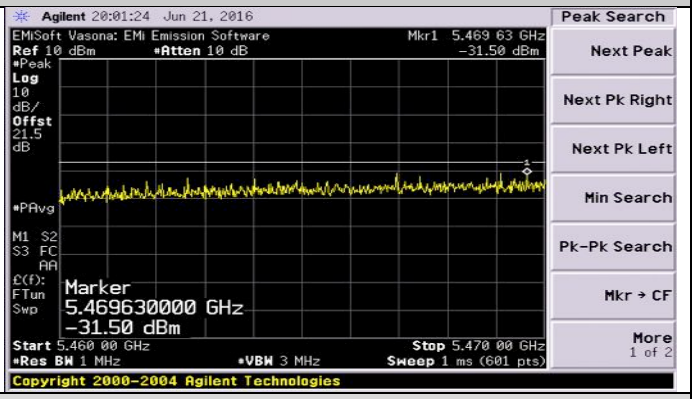
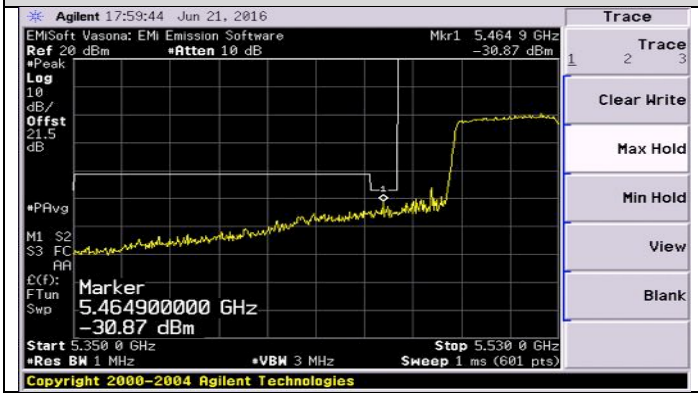
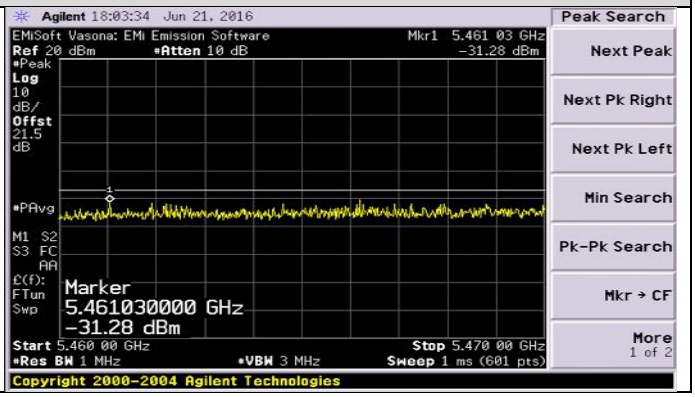
A.6.3 Conducted Band Edge & Non-restricted band Recorded Test Data

Lower Band Edge and Out-of-Band into Non-restricted band								
Operating Frequency (MHz)	**Data Rate (Mbps)**	**Measured Frequency (MHz)**	**Measured Emission Level (dBm/MHz)**	**A.G (dBi)**	**Duty Cycle**	**E.I.R.P (dBm)**	**Limit (dBm)**	**Result**
802.11a								
5500	6	5468	-30.98	3	N/A	-27.98	-27	Pass
802.11n20								
5500	MCS0	5468	-31.41	3	N/A	-28.41	-27	Pass
802.11n40								
5510	MCS0	5470	-30.78	3	N/A	-27.78	-27	Pass
802.11ac20								
5500	MCS0	5470	-36.70	3	N/A	-33.70	-27	Pass
802.11ac40								
5510	MCS0	5470	-31.50	3	N/A	-28.50	-27	Pass
802.11ac80								
5530	MCS0	5465	-30.87	3	N/A	-27.87	-27	Pass

Upper Band Edge and Out-of-Band into Non-restricted band								
Operating Frequency (MHz)	**Data Rate (Mbps)**	**Measured Frequency (MHz)**	**Measured Emission Level (dBm/MHz)**	**A.G (dBi)**	**Duty Cycle**	**E.I.R.P (dBm)**	**Limit (dBm)**	**Result**
802.11a								
5700	6	5725	-30.18	3	N/A	-27.18	-27	Pass
802.11n20								
5700	MCS0	5725	-31.48	3	N/A	-28.48	-27	Pass
802.11n40								
5670	MCS0	5726	-39.34	3	N/A	-36.34	-27	Pass
802.11ac20								
5700	MCS0	5725	-31.10	3	N/A	-28.10	-27	Pass
802.11ac40								
5670	MCS0	5725	-36.68	3	N/A	-33.68	-27	Pass
802.11ac80								
5530	MCS0	**5732**	-48.21	3	N/A	-45.21	-27	Pass

A.6.4 Conducted Band Edge and Non-restricted Band Graphical Test Results

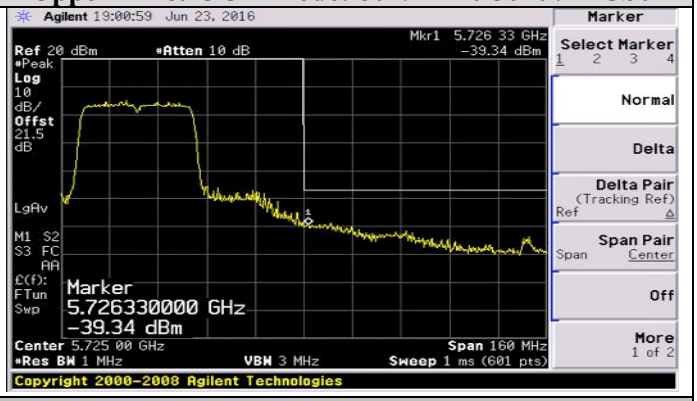
Lower Band Edge and Non-restricted Band Results	
Lower BE & OOB Mode: 802.11a 5500 MHz / 6Mbps	**(Zoom in non-restricted band) 802.11a / 5500 MHz**
	
Lower BE & OOB Mode: 802.11n20 5500 / MCS0	**(Zoom in non-restricted band) 802.11n20 / 5500 MHz**
	
Lower BE & OOB Mode: 802.11n40 5510 / MCS0	**(Zoom in non-restricted band) 802.11n40 / 5510 MHz**
	

Lower Band Edge and Non-restricted Band Results	
Lower BE & OOB Mode: 802.11ac20 5500 / MCS0	**(Zoom in non-restricted band) 802.11ac20 / 5500 MHz**
	
Lower BE & OOB Mode: 802.11a42 5510 / MCS0	**(Zoom in non-restricted band) 802.11ac40 / 5510 MHz**
	
Lower BE & OOB Mode: 802.11ac80 5530 / MCS0	**(Zoom in non-restricted band) 802.11ac80 / 5530 MHz**
	

Upper Band Edge and Non-restricted Band Results

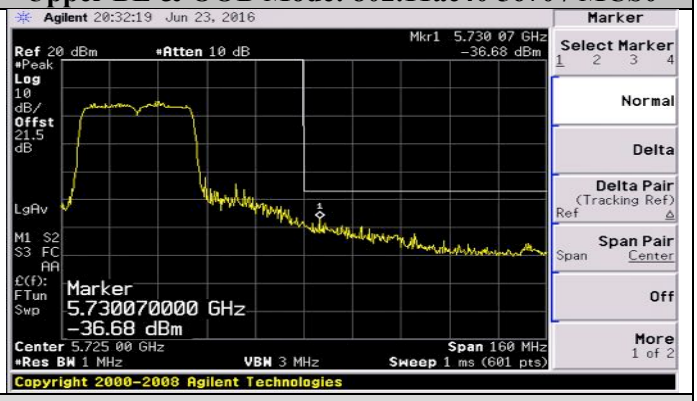
Upper BE & OOB Mode: 802.11a 5700 / 6 Mbps

Upper BE & OOB Mode: 802.11n40 5670 / MCS0

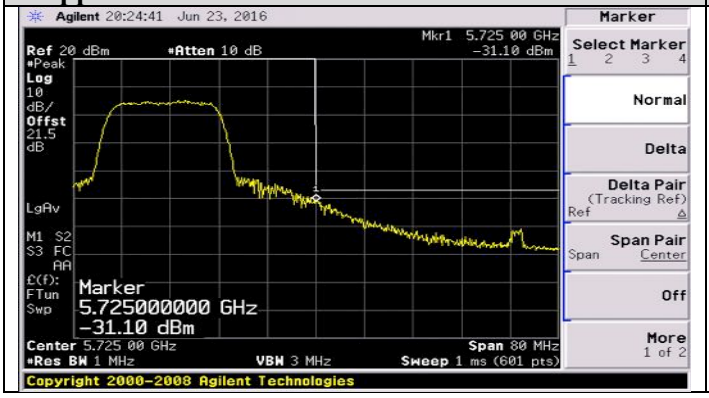


Upper BE & OOB Mode: 802.11n20 5700 / MCS0

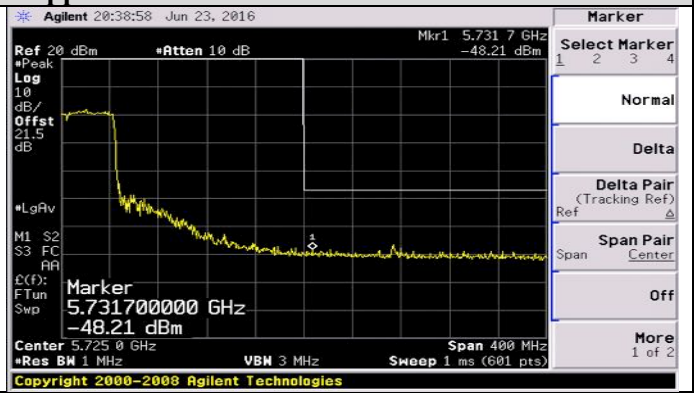
Upper BE & OOB Mode: 802.11ac40 5670 / MCS0



Upper BE & OOB Mode: 802.11ac20 5700 / MCS0



Upper BE & OOB Mode: 802.11ac80 5530 / MCS0



A.7 Restricted Bands

A.7.1 Limits.

FCC 15.205:

Radiated emissions which fall in the restricted bands, as defined in FCC §15.205(a), must also comply with the radiated emission limits specified in Sec. 15.209(a).

Limit Conversion (field strength to power)

When the DUT power is measured using conducted test method, the field strength limit in dBµV can be converted to power (logarithmic) by using the field strength (linear) approach formula as follows:

eirp = pt x gt = $(E \times d)^2 / 30$

where: **pt** = transmitter output power in watts,
gt = numeric gain of the transmitting antenna (unit less),
E = electric field strength in V/m,
d = measurement distance in meters (m).

From the equation above, unit conversion from log => linear with a known field strength limit of 74 dBµV @ 3 meters distance.

(1) Conversion from dBµV to V

E (v/m) = 10 exp $^{(74 - 120) / 20}$
E (V/m) = **0.0051187**

(2) Power in watts can be derived by using the equation above with known field strength in V/m with using antenna numeric gain of 1.

pt x gt = $(E \times d)^2 / 30$
pt (W) x gt = $(0.0051187)^2 \times (3)^2 / 30$
pt (W) x 1 = $(0.0000251188 \times 9) / 30$
pt (W) = $2.261 \times 10^{-4} / 30$ = **7.535566×10^{-6}**
pt (mW) = 0.007535566

(3) Convert from linear power to log, using the using the following formula:

dBm = 10 log (mW)
= 10 log (0.007535566)
= -21.23

A.7.2 Test Procedure

Ref. KDB 789033 D02 General UNII Test Procedure New Rules v01 section II G.1 (c)/ section II G.5 & G.6

Restricted Bands **Test Procedure**
1. The radio is configured in the continuous transmitting mode. 2. Set test parameters for peak measurement. 3. Set start frequency at the beginning of the restricted band and stop frequency at the end of the restricted band of interest. 3. Allow trace to fully stabilize. 4. Use marker peak search function to determine the maximum emissions amplitude within the restricted band. 5. Capture the transmitter waveforms on the spectrum analyzer, and record pertinent measurement data. 6. Set test parameter for average measurement. 7. Repeat step 3 – 5.

Ref. KDB 789033 D02 General UNII Test Procedure New Rules v01 section II G.5

Restricted Bands Peak Measurement **Test parameters**
Span = Enough to capture the full restricted band of interest RBW= 1 MHz VBW ≥ 3 x RBW Detector= Peak Trace Mode= Max. Hold Sweep time= Auto

Ref. KDB 789033 D02 General UNII Test Procedure New Rules v01 section II G.6

Restricted Bands Average Measurement Test parameters
Span = Enough to capture the full restricted band of interest RBW = 1 MHz VBW ≥ 3 x RBW Detector = RMS Averaging Type = Power average (RMS) Trace Average ≥ 100 Sweep time = Auto

A.7.3 Restricted Bands Recorded Test Data

Operating Frequency (MHz)	Data Rate (Mbps)	Restricted Bands (MHz)	S.A Reading (dbm)	A.G (dBi)	Duty Cycle (dB)	E.I.R.P (dBm)	Limit (dBm)	Result
802.11a								
5500	6	5350–5470	-35.27@5459 MHz	3	N/A	-34.95	-21.2	Pass
5500	6	5350–5470	-52.14*@5459MHz	3	0.315	-48.82*	-41.2*	Pass
802.11n20								
5500	MCS0	5350–5470	-38.44@5458MHz	3	N/A	-38.12	-21.2	Pass
5500	MCS0	5350–5470	-55.78*@5458MHz	3	0.315	-52.46*	-41.2*	Pass
802.11n40								
5510	MCS0	5350–5470	-38.06@5460MHz	3	N/A	-35.06	-21.2	Pass
5510	MCS0	5350–5470	-52.61*@5459MHz	3	1.113	-48.50*	-41.2*	Pass
802.11ac40								
5510	MCS0	5350–5470	-34.46@5459MHz	3	N/A	-31.46	-21.2	Pass
5510	MCS0	5350–5470	-49.37*@5456MHz	3	0.605	-45.76*	-41.2*	Pass
802.11ac80								
5530	MCS0	5350–5470	-32.27@5456MHz	3	N/A	-29.27	-21.2	Pass
5530	MCS0	5350–5470	-47.55@5458MHz	3	1.183	-43.37*	-41.2*	Pass

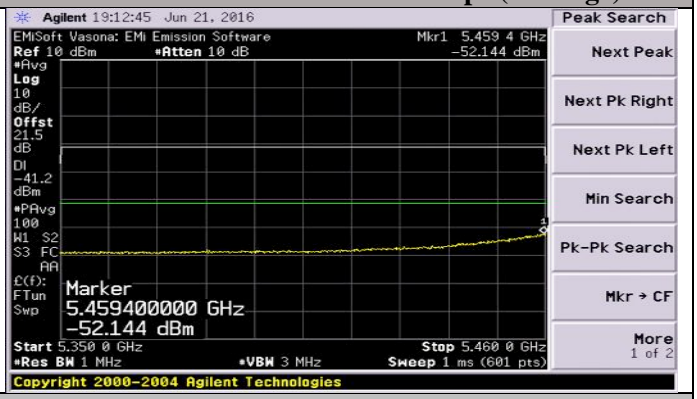
Note: Correction factors (ext. attenuation + cable loss) are compensated in the offset function of the measuring instrument. The readings with * at the end represent measurement in average.

A.7.4 Restricted Bands Graphical Test Results

Restricted Band (5350 MHz – 5460 MHz)

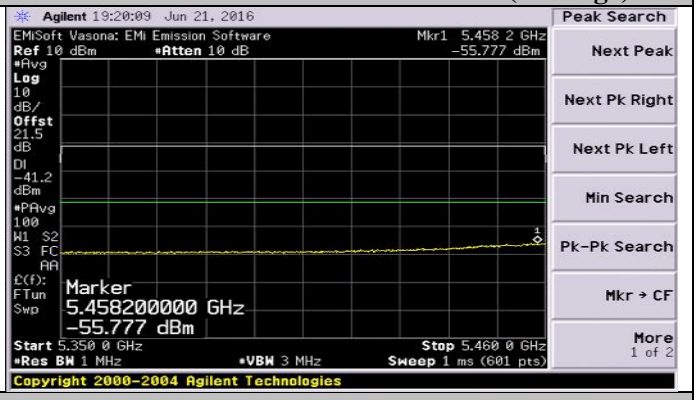
Mode: 802.11a 5500 MHz / 6Mbps (Peak)

Mode: 802.11a 5500 MHz / 6Mbps (Average)

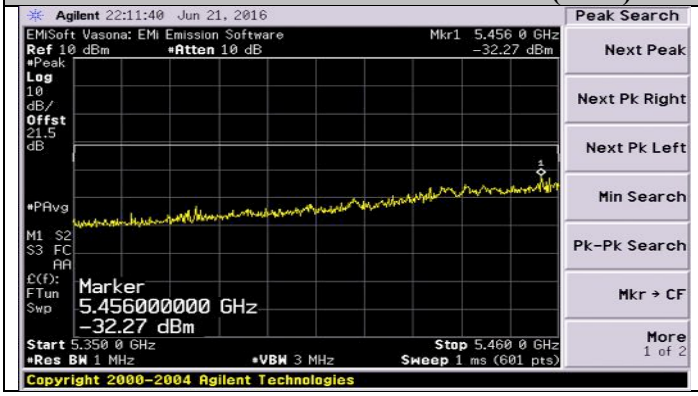


Mode: 802.11n20 5500 MHz / MCS0 (Peak)

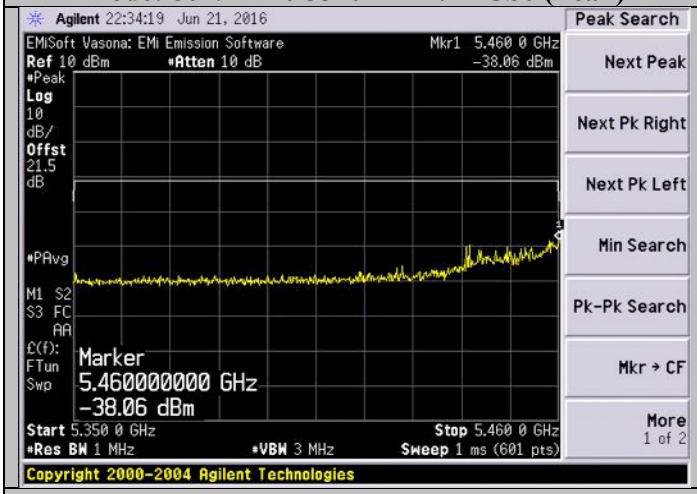
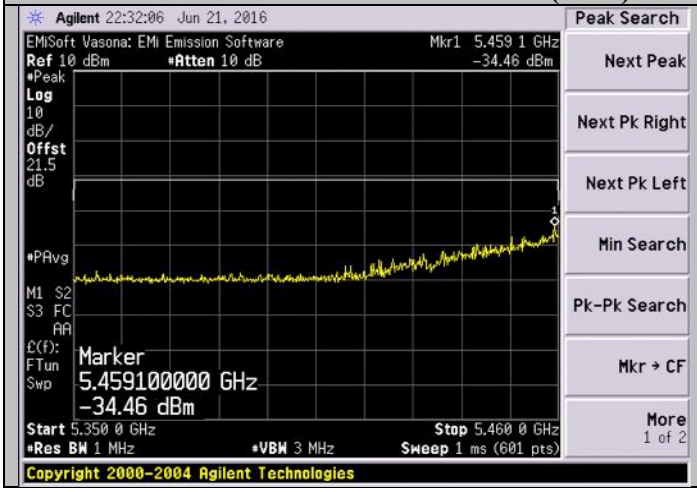
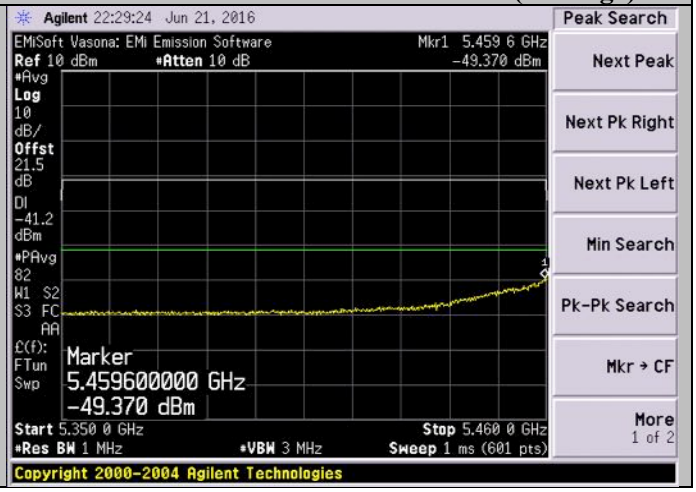
Mode:802.11n20 5500 MHz / MCS0 (Average)



Mode: 802.11ac80 5530 MHz / MCS0 (Peak)



Mode: 802.11ac80 5530 MHz / MCS0 (Average)

Restricted Band (5350 MHz – 5460 MHz)	
Mode: 802.11n40 5510 MHz / MCS0 (Peak)	**Mode:802.11n40 5510 MHz / MCS0 (Average)**
	
Mode: 802.11ac40 5510 MHz / MCS0 (Peak)	**Mode:802.11ac40 5510 MHz / MCS0 (Average)**
	

Appendix B: Radiated Test Results

B.1 Radiated Spurious Emissions & Restricted Bands

Unwanted Emissions Outside of the Restricted Bands

Frequency range: Below 1GHz
FCC 15.407 (b) (6): Unwanted emissions below 1GHz must comply with general field strength limits set forth in §15.209. Further any U-NII devices using an AC power line are required to comply also with conducted emissions limits set forth in §15.207. Refer to limit section for detailed limits

Frequency range: Above 1GHz
FCC 15.407 (b): Unwanted emissions above 1000 MHz that are outside of the restricted bands are subject to a maximum emission limit of -27 dBm/MHz (or - 17 dBm/MHz). Refer to limit section for detailed limits.

Restricted Bands

FCC 15.407 (b) (7): The provision of §15.205 apply to intentional radiators operating under FCC 15.407(b).

FCC 15.205 / FCC 15.209
Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).
Refer to limit section for detailed limits.

Restricted Bands			
MHz	**MHz**	**MHz**	**GHz**
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz

B.1.1 Limits.

For Restricted bands & below 1GHz

FCC 15.209: The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the table specified in the table in FCC§15.209(a).

FCC15.407 (b) (6): Unwanted emissions below 1GHz must comply with general field strength limits set forth in §15.209.

General Field Strength Limits Table			
Frequency (MHz)	**Field strength (uV/meter)**	**Field strength (dBuV/meter)**	**Measurement distance (meters)**
30-88	100**	40 Qp	3
88-216	150**	43.5 Qp	3
216-960	200**	46 Qp	3
Above 960	500	54 Av / 74 Pk	3

The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For Non-Restricted bands above 1GHz

FCC 15.407 (b): Undesirable emission limits. Except as shown in paragraph (b) (7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(3) For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz

Limit Conversion

When the DUT power is measured using a radiated test configuration, the EIRP can be directly determined using the field strength (linear) approach as follows:

eirp = pt x gt = (E x d)2/30

where: **pt** = transmitter output power in watts,
gt = numeric gain of the transmitting antenna (unit less),
E = electric field strength in V/m,
d = measurement distance in meters (m).

Based on the equation above, unit conversion from log => linear with a known limit of – 27 dBm

(1) Conversion from dBm to Watt

W = 10 EXP (-27dBm – 30 /10)
W = 10 EXP (-5.7) = 2 E-6

(2) E Field Strength can be derived by inverse calculation.

E = 9 (**pt** x **gt** x **30) / d**
E = SQRT (2E-6 x 1.0 x 30) / 3 = 0.0026 V/m

(3) Conversion from Linear to Log, using the following formula

Volts to dBuV = 20 log (*Volts)* + 120
E (in dBuV) = 20 Log (0.0026) + 120 = **68.23/m @ 3 meter**

B.1.2 Test Procedure

In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated in the equipment, whichever is lower, without going below 9 kHz, up to at least the frequency given below:

(a) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

(b) If the equipment operates at or above 10 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

Particular attention should be paid to harmonics and sub-harmonics of the carrier frequency, as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.

The amplitude of spurious emissions attenuated more than 20 dB below the permissible value need not be reported.

For emissions below 1000 MHz, measurements shall be performed using a CISPR quasi-peak detector and the related measurement bandwidth. Above 1000 MHz, measurements shall be performed using an average detector with a minimum resolution bandwidth of 1 MHz.

As an alternative to CISPR quasi-peak measurement, compliance with the emission limit can be demonstrated using measuring equipment employing a peak detector function properly adjusted for factors such as pulse desensitization as required, with an equal or greater than the applicable CISPR quasi-peak bandwidth or 1 MHz bandwidth, respectively.

Ref. ANSI C63.10-2013 section 6.5 & 6.6

Test Procedure
1. Using Vasona software, configure the spectrum analyzer as shown below (be sure to enter all losses between the transmitter output and the spectrum analyzer). 2. Place the radio in continuous transmit mode. Maximize Turntable (find worst case table angle) and maximize Antenna (find worst case height). 3. Use the peak marker function to determine the maximum amplitude level. 4. Center marker frequency and perform final measurement in Quasi-peak (≤ 1Ghz) and Average (above 1 GHz) 5. Record at least 6 highest readings for the worst case operating mode.

ANSI C63.10: 2013 section 4.1.4 / section 12.7.5 (Quasi-Peak), section 12.7.6 (peak), section 12.7.7.3 (average)

Test parameters
(i) Span = Entire frequency range or segment if necessary. (ii) Reference Level = 80 dBuV (iii) RBW = 100 kHz (less than or equal to 1 GHz); 1 MHz (above 1 GHz) (iv) VBW ≥ 3 x RBW (v) Detector = Peak & Quasi-Peak (frequency range 30 MHz to 1 GHz); Peak & Average (frequency range above 1 GHz); Change VBW to 10 Hz for average measurement (vi) Sweep Time = Couple

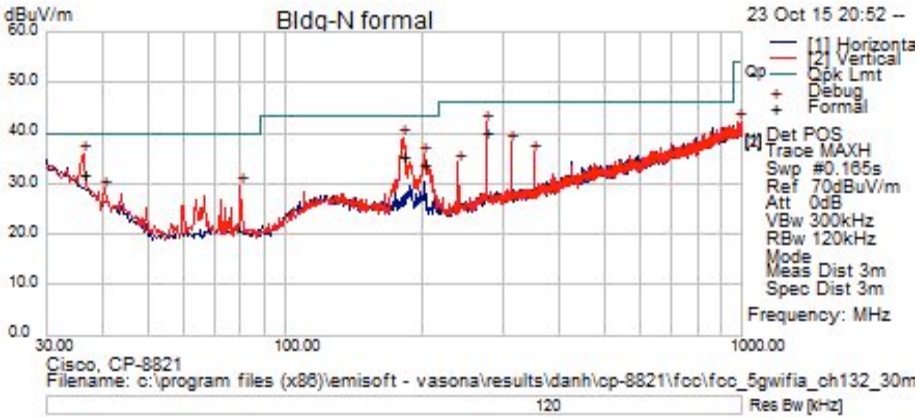
. The system was evaluated up to 40 GHz but there were no measurable emissions above 18 GHz.
. These data represent the worst case mode data for all supported operating modes and antennas.

Note1: A Notch Filter was used during formal testing from 1 – 18GHz to help prevent the front end of the analyzer from over loading. The Notch filters used are designed to suppress TX fundamental frequency but do not effect harmonics of the fundamental frequency from being measured

Note2: The data displayed on the plots detailed in the graphical test results section were measured using a 'Peak Detector'. Please refer to the results table for the detectors used during formal measurements.

B.1.3 Transmitter Radiated Spurious Emissions Graphical Data Results

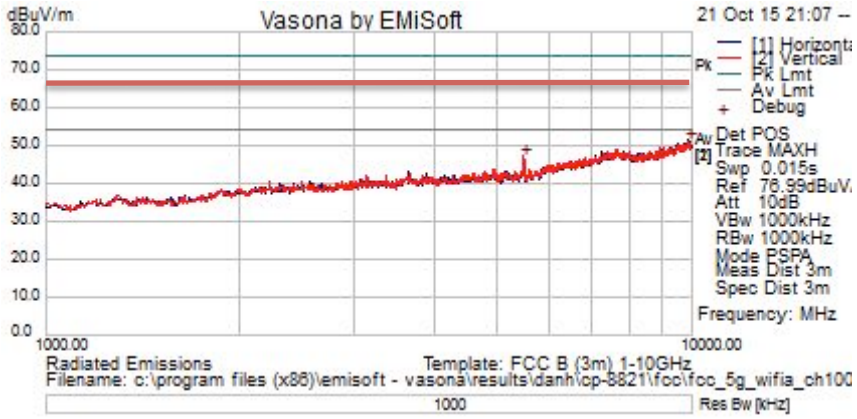
Subtest Date:	23-Oct-2015
Engineer	Danh Le
Lab Information	Building N, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	30MHz - 1GHz
Comments on the above Test Results	802.11a ,Tx Channel 132 (5660 MHz)



Title: **TX Spurious Emissions from 30MHz-1GHz – Ch132 (5660 MHz)**

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
276.4663	24.86	2.11	13.3	40.27	Quasi Max	V	0	106	46	-5.73	Pass	Tx/Ch132
180.9313	22.91	1.7	10.9	35.52	Quasi Max	V	134	113	43.5	-7.98	Pass	Tx/Ch132
201.7233	20.28	1.81	11.81	33.9	Quasi Max	V	110	244	43.5	-9.6	Pass	Tx/Ch132
36.14625	14.79	0.77	16.28	31.84	Quasi Max	V	101	344	40	-8.16	Pass	Tx/Ch132

Subtest Date:	21-Oct-2015
Engineer	Danh Le
Lab Information	Building N, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	1-10GHz
Comments on the above Test Results	802.11a, Tx Channel 100 (5500 MHz)



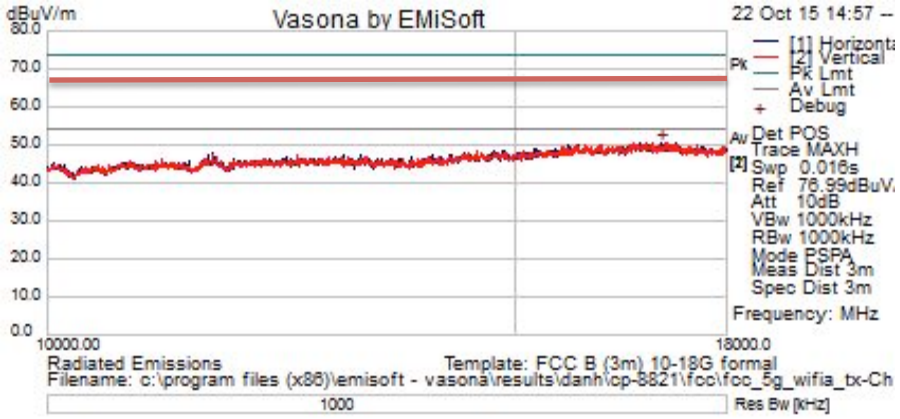
Title: **TX Spurious Emissions from 1-10GHz – Ch100 (5500 MHz) – Peak Trace**

Legend: 74dBµV/m (Peak); 54 dBµV/m (Average); 68dBµV/m (Peak) ~ -27dbm

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
9887.5	39.83	14.46	-2.83	51.47	Peak	H	225	206	54	-2.53	Pass	Tx/Ch100
5500	44.72	10.27	-7.86	47.12	Peak	V	300	250	54	-6.88	Pass	Tx/Ch100

Note: Where limits are specified by regulations for both average and peak detection, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement.

Subtest Date:	22-Oct-2015
Engineer	Danh Le
Lab Information	Building N, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	10-18GHz
Comments on the above Test Results	802.11a, Tx Channel 100 (5500 MHz)



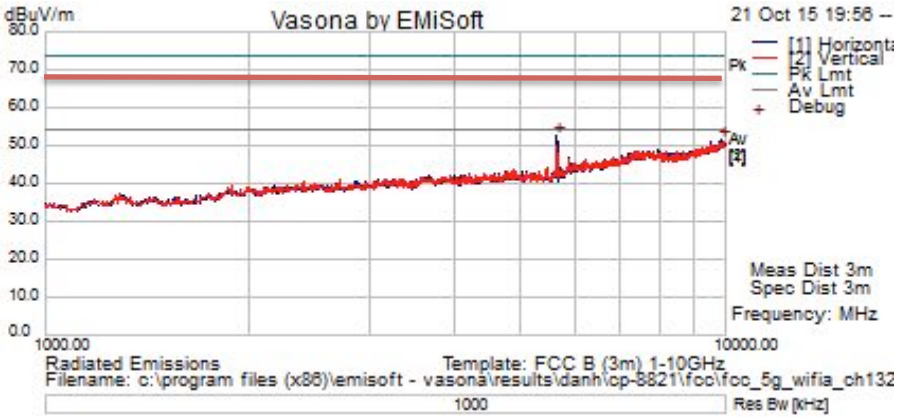
Title: **TX Spurious Emissions from 10-18GHz – Ch100 (5500 MHz) – Peak Trace**

Legend: 74dBµV/m (Peak); 54 dBµV/m (Average); 68dBµV/m (Peak) ~ -27dbm

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
17005	43.61	19.74	-12.72	50.63	Peak	H	125	293	54	-3.37	Pass	Tx/Ch100

Note: Where limits are specified by regulations for both average and peak detection, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement

Subtest Date:	21-Oct-2015
Engineer	Danh Le
Lab Information	Building N, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	1.0-10GHz
Comments on the above Test Results	802.11a ,Tx Channel 132 (5660 MHz)



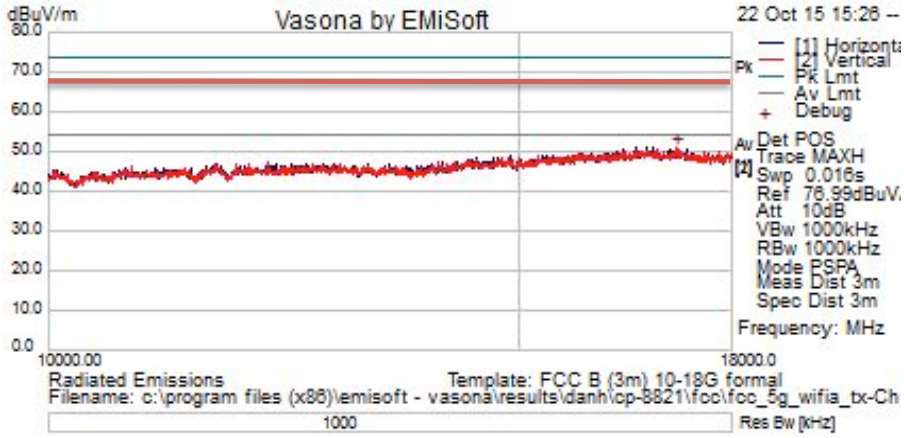
Title: **TX Spurious Emissions from 1-10GHz – Ch132 (5660 MHz) – Peak Trace**

Legend: 74dBµV/m (Peak); 54 dBµV/m (Average); 68dBµV/m (Peak) ~ -27dbm

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
5657.5	49.81	10.42	-7.38	52.85	Peak	H	275	264	54	-1.16	Pass	Tx/Ch132
9893.125	39.97	14.47	-2.78	51.66	Peak	H	150	338	54	-2.34	Pass	Tx/Ch132

Note: Where limits are specified by regulations for both average and peak detection, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement

Subtest Date:	22-Oct-2015
Engineer	Danh Le
Lab Information	Building N, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	10-18GHz
Comments on the above Test Results	802.11a ,Tx Channel 132 (5660 MHz)



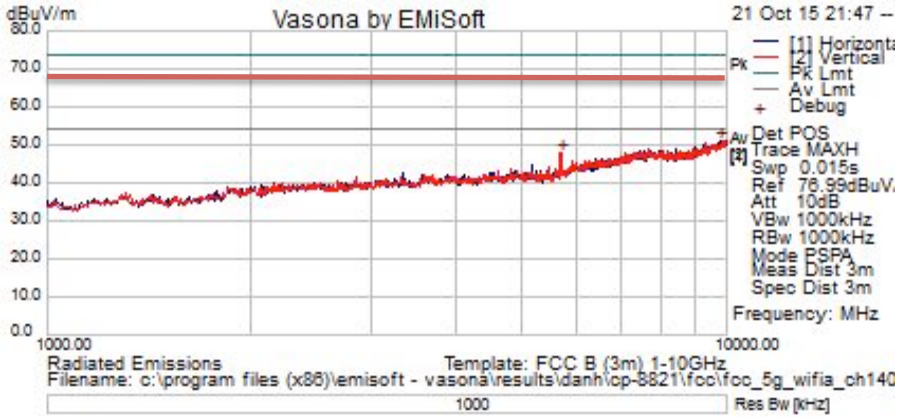
Title: **TX Spurious Emissions from 10-18GHz – Ch132 (5660 MHz) – Peak Trace**

Legend: 74dBµV/m (Peak); 54 dBµV/m (Average); 68dBµV/m (Peak) ~ -27dbm

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
17165	43.91	19.87	-12.55	51.23	Peak	V	300	225	54	-2.77	Pass	Tx/Ch132

Note: Where limits are specified by regulations for both average and peak detection, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement

Subtest Date:	21-Oct-2015
Engineer	Danh Le
Lab Information	Building N, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	1-10GHz
Comments on the above Test Results	802.11a, Tx Channel 140 (5700 MHz)



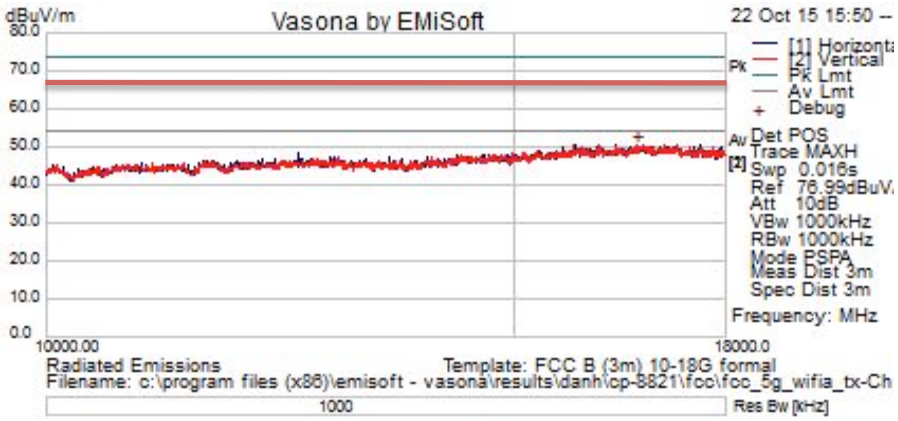
Title: **TX Spurious Emissions from 1-10GHz – Ch140 (5700 MHz) – Peak Trace**

Legend: 74dBµV/m (Peak); 54 dBµV/m (Average); 68dBµV/m (Peak) ~ -27dbm

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comment
9775	39.89	14.35	-3.05	51.19	Peak	H	250	33	54	-2.81	Pass	Tx/Ch140
5702.5	44.67	10.47	-7.18	47.97	Peak	V	175	92	54	-6.03	Pass	Tx/Ch140

Note: Where limits are specified by regulations for both average and peak detection, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement

Subtest Date:	22-Oct-2015
Engineer	Danh Le
Lab Information	Building N, 5m Anechoic
Subtest Title	Transmitter Spurious Emissions
Frequency Range	10-18GHz
Comments on the above Test Results	802.11a ,Tx Channel 100 (5700 MHz)



Title: **TX Spurious Emissions from 10-18GHz – Ch140 (5700 MHz) – Peak Trace**

Legend: 74dBµV/m (Peak); 54 dBµV/m (Average); 68dBµV/m (Peak) ~ -27dbm

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	AF (dB)	Level (dBuV)	Detector	Polarity	Height (cm)	Azt (Deg)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
16675	43.14	19.43	-11.89	50.68	Peak	V	225	170	54	-3.32	Pass	Tx/Ch140

Note: Where limits are specified by regulations for both average and peak detection, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement

B.2 AC Conducted Emissions

B.2.1 Limits.

FCC 15.207

Except when the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply, either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in the table in these sections. The more stringent limit applies at the frequency range boundaries.

B.2.2 Test Procedure

Measurement requirements
Ref: C63.10:2013, section 6.2.2

Measured levels of ac power-line conducted emission shall be the emission voltages from the voltage probe or across the 50 Ω LISN port (to which the EUT is connected), where permitted, terminated into a 50 Ω measuring instrument, or where permitted or required, the emission currents on the power line sensed by a current probe. All emission voltage and current measurements shall be made on each current-carrying conductor at the plug end of the EUT power cord by the use of mating plugs and receptacles on the LISN, if used. Equipment shall be tested with power cords that are normally supplied or recommended by the
manufacturer, and that have electrical and shielding characteristics that are the same as those cords normally supplied or recommended by the manufacturer. For those measurements, using a LISN, the 50 Ω measuring port is terminated by a measuring instrument having a 50 Ω input impedance. All other ports are terminated in 50 Ω loads. Figure 5, Figure 6, and Figure 7 show typical test setups for ac power-line conducted emissions testing (see 6.13). For information about the use of a RF-shielded (screen) room, vertical conducting plane and voltage probe, see ANSI C63.4.

Tabletop devices shall be placed on a platform of nominal size, 1 m by 1.5 m, raised 80 cm above thereference ground plane. The vertical conducting plane or wall of an RF-shielded (screen) room shall be located 40 cm to the rear of the EUT. Floor-standing devices shall be placed either directly on the reference ground-plane or on insulating material as described in ANSI C63.4. All other surfaces of tabletop or floor standing EUTs shall be at least 80 cm from any other grounded conducting surface, including the case or cases of one or more LISNs.

Final ac power-line conducted emission measurements
Ref: C63.10:2013, section 6.2.5

Based on the exploratory tests of the EUT performed in 6.2.4, the one EUT cable configuration and arrangement and mode of operation that produced the emission with the highest amplitude relative to the limit is selected for the final measurement, while applying the appropriate modulating signal to the EUT. If the EUT is relocated from an exploratory test site to a final test site, the highest emissions shall be remaximized at the final test location before final ac power-line conducted emission measurements are
performed. The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment in the system) is then performed for the full frequency range for which the EUT is being tested for compliance without further variation of the EUT arrangement, cable positions, or EUT mode of operation. If the EUT is comprised of equipment units that have their own separate ac power connections, e.g., floor-standing equipment with independent power cords for each shelf that are able to connect directly to the ac power network, each
current-carrying conductor of one unit is measured while the other units are connected to a second (or more) LISN(s). All units shall be separately measured. If a power strip is provided by the manufacturer, to supply all of the units making up the EUT, only the conductors in the power cord of the power strip shall be measured.

Record the six highest EUT emissions relative to the limit of each of the current-carrying conductors of the power cords of the equipment that comprises the EUT over the frequency range specified by the procuring or regulatory agency. Diagram or photograph the test setup that was used. See Clause 8 for full reporting requirements.

Ref. C63.10:2013, section 6.2

Test Procedure
1. Using Vasona software, configure the spectrum analyzer as shown above (be sure to enter all losses between the transmitter output and the spectrum analyzer). 2. Set the radio in continuous transmit mode. 3. Connect cable end to LISN Hot port and other cable end to the spectrum Analyzer/EMC receiver RF input port. Terminate the LISN neutral port with a 50 Ω impedance terminator. 4. Sweep the frequency range from 150 kHz to 30 MHz (segment if necessary) 5. Use the peak marker function to determine the maximum amplitude level. 6. Center marker frequency and perform final measurement using applicable detector (Quasi-Pk/Average). 7. Record at least 6 highest reading for the worst case operating modes in Quasi-peak/Average. 8. Repeat the test on Neutral lead. 9. Repeat step 3 – 7 with the radio sets in the Receiver mode. 10. Record at least 6 highest reading in Quasi-peak/Average

Ref. C63.10:2013, section 4 / CISPR16-1-1

Test Parameters
Span = Entire frequency range or segment if necessary. Reference Level = 70 dBuV RBW = 9 kHz VBW ≥ 3 x RBW Sweep Time = Couple Detector = Quasi-Peak & Average

B.2.3 Recorded Test Data and Graphical Test results

AC Conducted Emissions Test Result Tables for 802.11a / TX Ch132 (Peak, Quasi-Peak & Average)

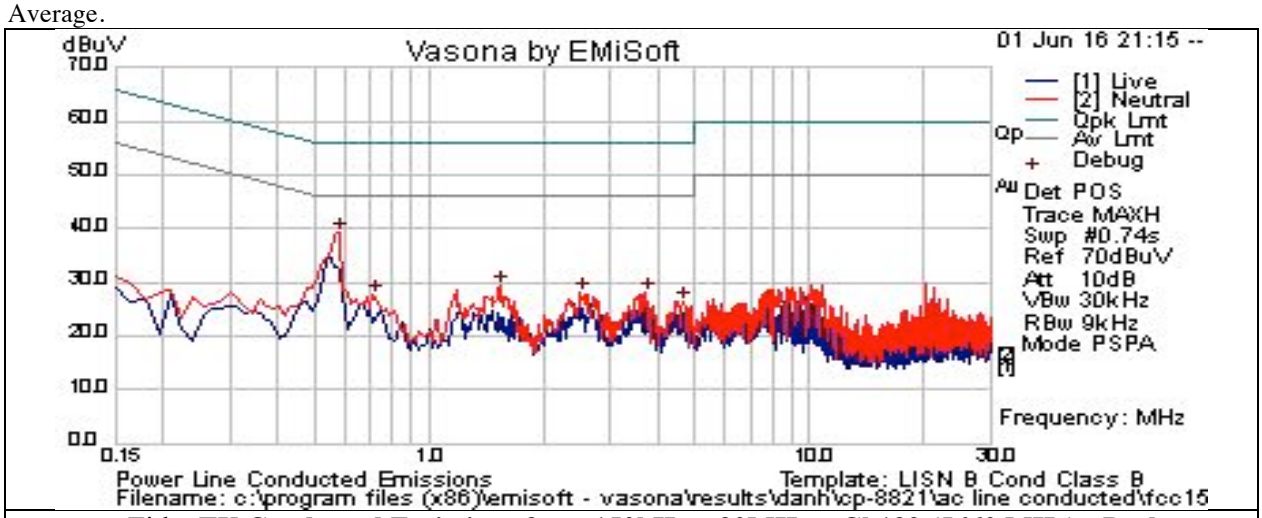
Subtest Date:	01-Jun-2016
Engineer	Danh Le
Lab Information	Building N, formal room
Subtest Title	Conducted Emissions
Frequency Range	150 kHz - 30 MHz
Comments on the above Test Results	TX Ch132 (5660 MHz) with BPSK modulation – 6 Mbps

Frequency (MHz)	Raw (dBuV)	Cab Loss (dB)	Factors (dB)	Level (dBuV)	Detector	Lines (Live/Neutral)	Limit (dBuV)	Margin (dB)	Results Pass / Fail	Comments
0.582825	19.13	20.04	0.04	39.21	Peak [Scan]	Neutral	46	-6.79	Pass	TX / Ch132
1.538025	9.18	19.99	0.05	29.22	Peak [Scan]	Neutral	46	-16.78	Pass	TX / Ch132
2.50815	8.04	19.99	0.04	28.07	Peak [Scan]	Neutral	46	-17.93	Pass	TX / Ch132
3.717075	7.92	20.02	0.05	27.99	Peak [Scan]	Neutral	46	-18.01	Pass	TX / Ch132
0.71715	7.63	20.03	0.04	27.7	Peak [Scan]	Neutral	46	-18.3	Pass	TX / Ch132
4.65735	6.32	20.05	0.05	26.42	Peak [Scan]	Neutral	46	-19.58	Pass	TX / Ch132

AC Conducted Graphical Test Results for 802.11a Mode:

Note: The data displayed on the plots detailed in this section were measured using a 'Peak Detector'. Please refer to the results table for the detectors used during final measurements.

When Peak readings are lower than Quasi-Peak & Average limits, it is not necessary to measure in Quasi-peak and Average.



Title: **TX Conducted Emissions from 150kHz – 30MHz – Ch132 (5660 MHz) - Peak**

Appendix C: List of Test Equipment Used to perform the test

Equip#	Manufacturer/ Model	Description	Last Cal	Next Due
CIS004882	EMC Test Systems / 3115	Double Ridged Guide Horn Antenna	19-AUG-15	19-Aug-16
CIS041944	Sunol Sciences / JB1	Combination Bi-Log Antenna, 30MHz-2GHz	21-JUL-15	21-JUL-16
CIS18313	HP / 8447D OPT 011	Dual Amplifier (0.1 – 13000 MHz)	28-APR-15	28-APR-16
CIS005691	Miteq / NSP1800-25-S1	Broadband Preamplifier (1-18GHz)	26-Jun-15	25-JUN-16
CIS39123	Cisco / THO118	Broadband Preamplifier (1-18GHz)	31-Mar15	31-Mar-16
CIS008100	Cisco / NSA 5m Chamber	NSA 5m Chamber	26-AUG-15	26-AUG-16
CIS035624	Rohde & Schwarz / ESCI	EMI Test Receiver	04-JUN-15	04-JUN-16
CIS024905	Agilent / E4440A	Precision Spectrum Analyzer	25-SEP-15	25-SEP-16
CIS44907	Rohde & Schwarz / ESCI	EMI Test Receiver	14-AUG-15	14-AUG-16
CIS08191	Fisher Custom Comm / FCC-450B-2.4-N	Pulse Limiter	07-JUL-15	07-JUL-16
CIS019208	TTE / H785-150K-50-21378	High Pass Filter 150KHz	09-DEC-15	09-DEC-16
CIS006565	Fisher Custom Com / 50/250-50-2-02	LISN (9kHz-30MHz)	03-MAR-16	03-MAR-17
CIS023911	Fisher Custom Com / 50-2-RA-NEMA-5-20R	LISN Receptacle Adaptor	03-MAR-16	03-MAR-17
CIS008531	Huber + Suhner / RG-223	25 ft RG-223 Cable	10-NOV-15	10-NOV-16
CIS051784	Huber+Suhner / Sucoflex 106PA	RF antenna Coaxial Cable, to 18GHz	06-JAN-15	06-JAN-16
CIS023697	Micro-Coax / UFB197C-1-3144-504504	RF Coaxial Cable, to 18GHz, 314.4 in	06-JAN-15	06-JAN-16
CIS008023	Huber+Suhner /Sucoflex SF106A	3 meter Sucoflex cable	06-JAN-15	06-JAN-16
CIS006697	Lufft / 5063-33W	Temperature/Humidity Gauge	09-MAR-15	09-MAR-16
CIS054416	Huber + Suhner/ Sucoflex 106PA	Sucoflex N Type Blue 3ft cable	28-APR-15	28-APR-16
CIS040503	Agilent / E4440A	Precision Spectrum Analyzer	10-JUN-15	26-May-17
CIS35619	TestEquity / HalfCube	Temperature Chamber	01-APR-15	01-APR-16
CIS51741	Rohde & Schwarz / NRP-Z81	Power Meter	19-JAN-15	19-JAN-16

Appendix D: Abbreviation Key and Definitions

The following table defines abbreviations used within this test report.

Abbreviation	Description	Abbreviation	Description
EMC	Electro Magnetic Compatibility	°F	Degrees Fahrenheit
EMI	Electro Magnetic Interference	°C	Degrees Celsius
EUT	Equipment Under Test	Temp	Temperature
ITE	Information Technology Equipment	S/N	Serial Number
TAP	Test Assessment Schedule	Qty	Quantity
ESD	Electro Static Discharge	Emf	Electromotive force
EFT	Electric Fast Transient	RMS	Root mean square
EDCS	Engineering Document Control System	Qp	Quasi Peak
Config	Configuration	Av	Average
CIS#	Cisco Number (unique identification number for Cisco test equipment)	Pk	Peak
Cal	Calibration	kHz	Kilohertz ($1x10^3$)
EN	European Norm	MHz	MegaHertz ($1x10^6$)
IEC	International Electro technical Commission	GHz	Gigahertz ($1x10^9$)
CISPR	International Special Committee on Radio Interference	H	Horizontal
CDN	Coupling/Decoupling Network	V	Vertical
LISN	Line Impedance Stabilization Network	dB	decibel
PE	Protective Earth	V	Volt
GND	Ground	kV	Kilovolt ($1x10^3$)
L1	Line 1	μV	Microvolt ($1x10^{-6}$)
L2	Line2	A	Amp
L3	Line 3	μA	Micro Amp ($1x10^{-6}$)
DC	Direct Current	mS	Milli Second ($1x10^{-3}$)
RAW	Uncorrected measurement value, as indicated by the measuring device	μS	Micro Second ($1x10^{-6}$)
RF	Radio Frequency	μS	Micro Second ($1x10^{-6}$)
SLCE	Signal Line Conducted Emissions	M	Meter
Meas dist	Measurement distance	Spec dist	Specification distance
N/A or NA	Not Applicable	SL	Signal Line (or Telecom Line)
P	Power Line	L	Live Line
N	Neutral Line	R	Return
S	Supply	AC	Alternating Current

Appendix E: Software Used to Perform Testing

EMIsoft Vasona, version 6.024

Appendix F: Test Procedures

Measurements were made in accordance with

- ANSI C63.10:2013 Procedure for Compliance Testing of Unlicensed Wireless Devices
- KDB Publication No. 789033 - D02 General UNII Test Procedures New Rules v01
- KDB 644545 D03 Guidance for IEEE 802.11ac v01

Test procedures are summarized below:

FCC 5GHz Test Procedures	EDCS # - 1445048
FCC 5GHz RSE Test Procedures	EDCS # - 1511600

Appendix G: Scope of Accreditation

(A2LA certificate number 1178-01)

The scope of accreditation of Cisco Systems, Inc. can be found on the A2LA web page at:

http://www.a2la.org/scopepdf/1178-01.pdf

Appendix H: Test Assessment Plan

Compliance Test Plan (Excel) EDCS- 1534002
Target Power Tables EDCS-882940

Appendix I: Worst Case Justification

Worst case modes were selected by ANSI C63.10 2013 Section **5.6.2.2**

For devices with multiple operating modes, measurements on the middle channel can be used to determine the worst-case mode(s). The worst-case modes are as follows:

a) Band edge requirements—Measurements on the mode with the widest bandwidth can be used to cover the same channel (center frequency) on modes with narrower bandwidth that have the same or lower output power for each modulation family (e.g., OFDM and direct sequence spread spectrum).

b) Spurious emissions—Measure the mode with the highest output power and the mode with the highest output power spectral density for each modulation family (e.g., OFDM and direct sequence spread spectrum).

c) In-band PSD—Measurements on the mode with the narrowest bandwidth can be used to cover all modes within the same modulation family of an equal or lower output power provided the result is less than 50% of the limit.